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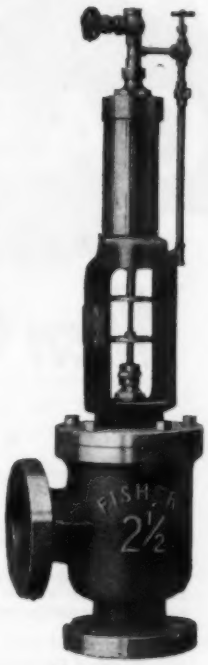

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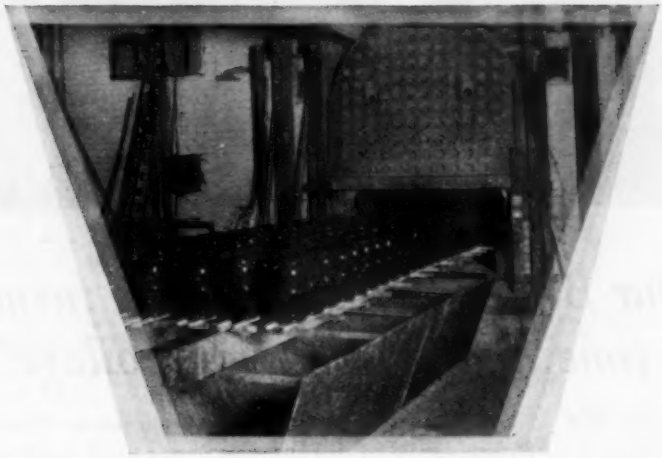

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VACUUM TREATMENT OF CLAY SLIPS AND BODIES[1]

By Hobart M. Kraner and A. H. Fessler

ABSTRACT

The work contained in this paper was conducted to determine the value of the treatment of clay slips to reduced pressures. Theoretical information obtained in references, however, indicate little possibility of there being much gas adsorbed by the solid particles of a porcelain slip. No improvement of dielectric strength or mechanical strength could be noted as a result of experimental work conducted.

Introduction

Air may be held by clay slips or bodies in either of two ways. The first of these is the mechanical trapping of air bubbles due to high viscosity of the slip or plastic body. Where there has been sufficient and proper stirring of the slip, the air thus held can be removed. Blunger and agitator paddles bring these air bubbles to the top of the slip. Filter pressing and subsequent pugging break up or remove the entrapped air bubbles, or so change the structure of the mass that they become insignificant in the new structure.

In casting, the bubble must be removed in agitators or it remains as such, a bleb, in the cast piece just as is sometimes seen in a section of solid plaster of Paris or cement.

The other method of entrapping or holding air is by adsorption. Where a gas is adsorbed by a solid, the layer of gas surrounding the solid particle is so strongly held by the material that the density of the gas is very markedly increased. In the case of charcoal the density of the gas adsorbed on its surface has been shown to be approximately that of the liquefied gas and the pressure with which it is held is approximately 900 atmospheres. As a result of these conditions, liquefaction of the gas on the surface, solid solution with the solid, or chemical reaction with the solid may explain the tendency of a solid to adsorb large volumes of a gas.

J. L. Briggs[2] calculates that the moisture adsorbed on a surface of quartz from a saturated atmosphere approximates 0.0000266 mm. in thickness. There is a large amount of information available on this subject which indicates that the wetting of some solids with water by adsorption produces heat and an evolution of air. This would indicate there is a probable preferential adsorption of water over air, and that the adsorbed air is expelled by reason of this preferential adsorption when a piece of dry clay is immersed in water. Jamin[3] found that the tendency of water to drive air from a porous piece of chalk

[1] Received May 28, 1928.

[2] *Jour. Physical Chemistry*, **9**, 617 (1905).

[3] Chwolson *Traite de Physique*, **1**, III, 622 (1907); Bancroft, Applied Colloid Chemistry, p. 77.

amounted to 3 to 4 atmospheres. Spring[4] obtained a pressure of 1/5 atmosphere when water displaced the air in contact with or adsorbed by sand. Whether or not this air had been adsorbed or merely held in the pores we dare not say but it indicates a strong affinity of these inorganic materials for water similar to that shown by clays when they are exposed to water or water vapor.

Searle[5] may be quoted as follows:

> Clay behaves like a colloid in its power of adsorbing liquids. In the first place it is wetted by water, alcohol, and various other fluids, and for such "wetting" to occur the clay must adsorb the liquid more strongly than the air which was previously in contact with its surface and filling its pores. The manner in which a piece of fired clay will adhere to the tongue is well known. This is due to the water being adsorbed by the clay and the air previously contained in the pores being displaced. The pressure exerted by the water appears to be about five atmospheres.

We do not have any data showing the volume of air adsorbed per unit volume or weight of clay, or the effect of temperature or pressure on the volume adsorbed by clays. In the case of charcoal which is the notable adsorbant of air and other gases, there are considerable data available which indicates that a decrease of temperature rapidly increases the amount of gases adsorbed whereas the change in adsorption is not so great with changes in pressure.

Limitation of Pressure Reduction Methods on Slips and Bodies

Since slip is both a suspension and a solution the laws for vapor pressure probably hold as for solution. The content of soluble material in slip is low and the vapor pressure will not vary far from that of water.

At 100°C water has a vapor pressure of 760 mm. At 25°C it has a vapor pressure of 23.69 mm. At these respective temperatures and at these pressures water will boil. Therefore if one places slip (or water) at 25°C in a closed vessel and reduces the pressure to 23.60 mm., the boiling might be mistaken for air removal.

If a piece of plastic clay were subjected to such a reduction of pressure, bloating to the detriment of the mass would probably take place unless suddenly subjected to a high pressure, either mechanically or by air. If the same is done on a slip no particular damage except perhaps foaming would result.

Any reduction of pressure would, of course, increase the rate of water removal from the slip or plastic body. Such a rapid removal of water might not be desirable where best control of factory conditions is being sought.

---

[4] *Mem. Soc. Belge, Geologie*, 97, 13 (1903); Bancroft, Applied Colloid Chemistry, p. 77.

[5] The Chemistry and Physics of Clays and Other Ceramic Materials, p. 239.

The foregoing points indicate little probability of there being much air in slips, the removal of which would warrant serious consideration. There has been some interesting work reported along these lines, however, and it seemed therefore that some features of the process not considered might make it valuable and it should be investigated.

Scope of This Work

It is the purpose of this work (1) to determine the amount of gas removable from slips at room temperature by reductions of pressure practical in factory operation; (2) to determine the effect of subjecting the slip to reduced pressure upon the dielectric strength of the fired porcelain; and (3) to determine the effect of subjecting the slips to reduced pressure upon the mechanical strength of the fired porcelain.

Procedure

Figure 1 shows an apparatus for determining the content of gas in slips. A known volume of slip is placed in bulb *A*. The seals at the top are made secure with wax and mercury; the stop-cock is opened to the atmosphere. The slip is under atmospheric pressure.

FIG. 1.

A few drops of the slip are placed in bulb *B* to compensate for the vapor pressure of the liquid in *A*. It is recognized that this compensation does not hold in determinations in which it is desired to obtain pressures below the boiling pressure of the slip which therefore cannot be made in this apparatus. Pressure in *B* is reduced by vacuum through upper limb and 3-way stop-cock. *A* and *B* are then connected by the 3-way stop-cock. From the readings taken, the barometric pressure, Boyle's law, etc., the following is derived:

$$P_{At}V_A+P_B'V_B=P''(V_A+V_B+V_C-V_X)$$
$$V_X=P_{At}V_A+P_B'V_B-P''V_A-P''V_B-P''V_C$$

where,

V_A = volume of bulb A, neck and leg.
V_B = " " " B, " " legs to mercury at P'.
V_C = increased volume in depressed leg.
P_{At} = atmospheric pressure.
P'_B = reduced pressure in B.
P'' = reduced pressure in AB when combined.
V_X = volume of gas released from slip.

Successive determinations with final pressures (P'') of 20.9 cm. and 13.6 cm. gave volumes of 3.69 and 4.55 cc., respectively, from 355 and 351 cc. of slip. These values represent 1.04% and 1.29% by volume.

The slip used was regular production plastic process slip taken from the blunger when ready for filter pressing. Its temperature was approximately 25°C and no boiling therefore took place at this pressure.

Dielectric Strength

Two separate batches of factory casting slip subjected to a reduction of pressure were cast into cups for test. These cups were allowed to cast exactly ten minutes. The bottoms were evened to the same thicknesses before firing.

Other sets were cast from slip not having been so treated and the thickness of the bottom of the cups corrected in like manner before firing.

The results of these tests are as follows:

Regular Casting Slip (no reduced pressure treatment)			Regular Casting Slip (2 cm. pressure for 1 hr. before casting) (boiled)		
KV to puncture	Thickness mils	Volts per mil	*KV* to puncture	Thickness mils	Volts per mil
46	130	354	44	135	325
50	137	365	45	130	346
46	141	326	47	135	348
48	145	331	49	141	348
40	129	310	37	132	280
46	142	324	36	134	269
44	127	346	46	134	343
44	135	325	42	136	309
44	136	324	44	135	326
46	138	333	46	134	343
38	131	290	44	132	334
42	140	300	44	128	344
46	139	331	46	134	344
44	142	310	42	133	316
44	131	337	46	133	346
44	137	321	38	133	286
			48	137	350
		Av. 326.6			Av. 326.8

Mechanical Strength

A batch of regular production plastic process porcelain slip representing approximately 20 lbs. of dry material was subjected to a reduced pressure of 2.0 cm. mercury, for one hour and filter pressed. The filter press was so arranged that the operation consisted of subjecting to reduced pressure and then filter pressing by admitting compressed air to the tank, forcing the slip into the leaves of the press. No handling and probable entrapping of air in the slip through such handling was necessary by this operation.

Another such quantity of slip was filter pressed without the evacuating treatment. The plastic clay in each case was wedged by hand sufficiently to prepare for use in an extrusion apparatus. Round bars were made by extruding from the extrusion apparatus consisting of a cylinder containing the plastic clay from which the clay was forced

through a die by an electrically driven plunger. By this means no pug mill defects were obtained in the test specimen. These bars were all fired in regular production kilns at a uniform temperature. They were all 10.6 mm. in diameter and required the following energy values to break them on a 4.6 cm. span of the apparatus (shown in Fig. A12* of the Standards Report) when a 10 cm. kg. pendulum was used.

Cm. Kg. Required to Break Bar by Impact

I	II
1.442 cm. kg.	1.528 cm. kg.
Av. of 43 bars	Av. of 52 bars
Slip evacuated at 2 cm. 1 hr.	Slip untreated
Bars extruded at atmospheric pressure	Bars extruded at atmospheric pressure

Conclusions

The conclusions obtained from these data are as follows:

(1) Since there appears to be only 1 to 1.3% air by volume in the slip, the increase in density of a slip from which this air has been removed will be very slight. It would also seem to indicate that the effect of the removal of this very small content of air from a slip is negligible in view of the fact that 30% of the volume of a piece of bone dry porcelain is voids which must necessarily be closed up during the vitrification process.

(2) The dielectric strength of the porcelain is not increased by such treatment.

(3) No noticeable improvement in mechanical strength of porcelain so treated can be noted by such treatment.

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* Navias, *Jour. Amer. Ceram. Soc.*, **10** [2], 93 (1927); *ibid*, **11** [6], 509 (1928).

A WASTE HEAT DRYING SYSTEM INVOLVING RECUPERATION[1]

By W. T. Windsor and F. C. Westendick

ABSTRACT

In an attempt to eliminate the smoke nuisance created by operating a brick plant within the limits of a city, a successful smoke eliminator and a waste-heat drying system involving recuperation were developed after some experimenting on old and new methods. The construction and arrangement of the recuperator is described as follows: A complete double-deck duct system was built carrying the combustion gases in the lower half and the waste heat in the upper half. In this system a damper chamber is constructed at each kiln where the outlet flue leaves the kiln. The kiln outlet flue enters this chamber on the one side and the gas and waste-heat ducts one above the other leave on the other side. Both of these ducts are fitted with dampers. The construction of these chambers and the main duct is described. The advantages, limitations, and cost of this system are discussed.

Introduction

This investigation was begun after difficulties had been encountered with the city authorities in regard to the smoke nuisance created from operating a brick plant within the limits of a fairly large city. Short-time permits from the smoke inspector were issued while experiments were carried on as to the relative merits of the different methods of smoke elimination used at other plants. None of these methods was successful in this plant.

Three 150 horse-power boilers were operated at this plant using the exhaust steam for drying during the day with live steam at night, the drying cycle being twenty-four hours. The firing time was seven days for standard building brick, using coal in 32-foot round downdraft kilns with 60-foot stacks, firing with dead-bottom fire boxes.

No plant was found in which drying could be completed in twenty-four hours with waste heat in the severe winter months if the heat was taken from the door of the kilns by goosenecks. There were some plants in which the horse-power required to utilize the waste heat cost more than to dry by direct-fired tunnels or steam.

It was decided to try an entirely new method which would effect not only a new drying system but an induced-draft firing system and smoke eliminator. This plan was the complete electrification of the plant, changing from steam to heated fresh air drying, and replacing stack draft with induced or fan draft.

The System Adopted

Heating and Drying

The process of electrifying the factory was easy. A 250 horse-power synchronous motor and sub-

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Heavy Clay Products Division.)

station was substituted for the boilers and engine. The drying system embraced the idea of drawing, through a single-brick tunnel, all combustion gases while the kilns were being fired and waste heat when kilns were being fired off, through the same flue that had originally connected with the kiln stacks to a central fan house. Within the fan house three interchangers or recuperators 10 feet long, 42 inches wide, and 42 inches deep, built of No. 8 gage blue-annealed plates were placed in this duct just ahead of the fan intake. The function of the interchangers was to dissipate the combined heat of the gases and waste heat through the steel plates into fresh air drawn in the opposite direction by the drier fan. The gases would arrive at the interchangers at about 700 to 1000°F according to the stage of firing and cooling the kilns. Passing through the interchanger they would lose from 20 to 30% of their heat. The fresh air passing through the interchanger in the opposite direction, if entering at 60°F, would increase in temperature from 140 to 195°, entirely dependent on the volume of air flowing and the temperature of the entering gases.

With this system difficulties arose almost at once. It was impossible to keep the gases above 700°F and at or below that temperature the sudden loss of temperature while passing through the interchangers caused a deposit of soot and sulphuric acid on the plates and eventually stopped up the passages. These were cleaned out thoroughly several times during a forced shut-down, but in a short time the incoming temperature would drop because of the starting of a cold wet kiln, the draft would be lost and consequently the temperature in the drier.

After months of failure, the interchangers were taken out and the waste heat was carried directly to the drier fan by way of a fireclay sewer pipe laid within the gas duct. The gases should raise the temperature of the waste heat sufficiently to admit enough fresh air at the fan to make up the quantity required to dry in twenty-four hours. This plan worked perfectly at the outset but the sewer pipe soon cracked and finally collapsed.

A Double-Deck System

A complete double-deck duct system was then built carrying the combustion gases in the lower half and the waste heat in the upper half. In this system a damper chamber is constructed at each kiln where the outlet flue leaves the kiln. The kiln outlet flue enters this chamber on the one side and the gas and waste-heat ducts one above the other leave on the other side. Both of these ducts are fitted with cast-iron dampers $^3/_8$ inch thick and 36 inches square, which recline at 20° from the vertical and have proved quite practical. The lower

damper is simply lifted by the fireman when the kiln is lit and the upper damper is lowered to draw the waste heat when cooling.

The main duct is built of 12-inch brick walls with a two-ring brick arch cover and a single-ring arch across the center to divide the duct into an upper compartment for waste heat and a lower compartment for the combustion gases. This dividing arch is coated with one inch of five parts sand, one part ground shale, and one part cement, and apparently is quite serviceable in preventing leaks from the lower compartment to the upper as the draft is always stronger in the waste-heat compartment.

The waste heat is discharged by the drier fan into a main duct having damper connections with each tunnel. A stack is used at the other end of the tunnels for the drier exhaust.

The best draft conditions for the firing of common brick from the point of economy, time, and quality are 0.48-inch water gage the first 30 hours, 0.36 inch the next 48 hours, and 0.20 inch thereafter. Any care or expense used to obtain tight-fitting dampers will be more than repaid in saving in horse-power. Kilns can be cooled in two and one-half days in the winter and three and one-half days in the summer.

Conclusions

The high lights of these experiences have been as follows:

(1) Smoke can be successfully eliminated using the interchanger principle.

(2) The interchanging of heat is practical only when a temperature can be kept above 700°F at the cool end of the interchanger.

(3) Sewer pipe even of double strength and made of fire clay will not stand much difference between inside and outside temperatures.

(4) Double-deck heat ducts can be built of brick and maintained practically leak-proof.

(5) There is more than enough waste heat from one kiln if taken from the bottom to dry an equal number of brick in a drying time of 24 hours or less.

(6) It requires 4200 cu. ft. of air per min. at or above 184°F to dry thoroughly each tunnel of 12 cars or 7200 brick in 24 hours.

(7) Brick thoroughly dry can hardly be scummed in the kiln.

(8) Induced-draft or fan-draft drawing the combustion gases of all kilns through one fan will give satisfactory smoke elimination.

(9) It requires an average of six horse-power per kiln for induced draft and one-half horse-power per brick for waste heat.

(10) The horse-power in both cases could be reduced by building larger ducts and locating the fans to bring about the shortest possible course.

(11) Firing schedules can be maintained in any kind of weather as there is no interference with kiln draft.

(12) The system costs slightly more than $1000.00 per kiln.

(13) If necessary, cooling of a kiln can be hurried by drawing the waste heat through both systems at the same time.

(14) No waste heat need be sent through the driers on Sunday, thereby saving twenty-four hours in horse-power by shutting off the waste heat fan. If there is a necessity for cooling a kiln over Sunday this can be accomplished by drawing the waste heat through the combustion gas system.

(15) Only the kiln fireman is needed to adjust the dampers to any desired system within a few minutes' time.

WINDSOR BRICK COMPANY
AKRON, OHIO

THE HEAT BALANCE OF A GLASS TANK FURNACE[1]

By Robert D. Pike and George H. West

ABSTRACT

A seventy-two hour test was carried out on a continuous side-fired regenerative glass tank furnace with five oil burners on each side. A novel feature of this furnace was the insulation of the entire silica brick cap by means of a high temperature insulating brick. A complete record of the furnace operation during this period is given. Temperature measurements were made at various points in the furnace and regenerator. A feature of the temperature observations is the great magnitude of the radiation correction when hot gases are flowing through passages lined with cooler brick work. The method described by Kreisinger and Barkley was used in making these measurements. This method could be employed for direct reading of true temperature at any point in the regenerative system. The heat balance of the complete furnace system between points at bottom of regenerators is given. Possible savings of fuel amounting to 14% of the total fuel burned are shown. An important fact brought out by this heat balance is that leakage through furnace brickwork is as prolific a source of heat loss as flow of heat through them by conduction.

Introduction

The furnace referred to, illustrated in Figs. 1 and 2, is the same as that to be described in another publication,[2] in which paper are given the data on the quantity and analysis of air and gases of combustion which are used in calculating the heat balance of this paper.

This is a continuous side-fired regenerative glass tank furnace with five oil burners on each side. The area of the glass pool in the melting end is 830 square feet and in the nose end beyond the bridge wall 251 square feet. The feed is to automatic machines. A novel feature of this furnace is the insulation of the entire silica brick cap, made of 11-inch silica brick, with insulating brick made of a special grade of high temperature resistant diatomaceous earth.

Operating Features

During the seventy-two hour test the operation of the furnace was continuous and uniform as shown in Tables I and II.

TABLE I
RECORD OF FURNACE CHARGES DURING TEST PERIOD
(8:00 A.M. Oct. 3 to 8:00 A.M. Oct. 5)

Shift 1		Shift 2		Shift 3	
Time	No. Cars	Time	No. Cars	Time	No. Cars
8:15	3	4:15	3	12:15	3
9:00	3	5:00	4	1:00	4
9:45	3	5:45	3	1:45	3
10:30	3	6:30	3	2:30	4
11:45	3	7:15	4	3:15	3
12:15	3	8:15	3	4:15	4
1:00	3	9:00	4	5:00	3
1:45	3	9:45	3	5:45	4

[1] Received May 17, 1928.

[2] Robt. D. Pike, "Calculation of Carbon Balance of Metallurgical Furnaces," to be published in *Jour. Ind. Eng. Chem.*

TABLE I (*Continued*)

Shift 1		Shift 2		Shift 3	
Time	No. Cars	Time	No. Cars	Time	No. Cars
2:30	3	10:30	4	6:30	3
3:15	3	11:15	3	7:15	4
8:15	3	4:15	3	12:15	3
9:00	3	5:00	4	1:00	4
9:45	4	5:45	3	1:45	3
10:30	3	6:30	3	2:30	4
11:45	4	7:15	4	3:15	3
12:15	3	8:15	3	4:15	4
1:00	3	9:00	4	5:00	3
1:45	4	9:45	3	5:45	4
2:30	3	10:30	4	6:30	3
3:15	3	11:15	3	7:15	3
8:15	3	4:15	3	12:15	3
9:00	4	5:00	3	1:00	3
9:45	3	5:45	3	1:45	3
10:30	3	6:30	3	2:30	3
11:45	4	7:15	3	3:15	2
12:15	3	8:15	3	4:15	3
1:00	3	9:00	3	5:00	3
1:45	3	9:45	3	5:45	3
2:30	3	10:30	3	6:30	3
3:15	3	11:15	3	7:15	2

Total cars for 72 hours	290
Average weight per car	1281 lbs.
Total number of charges	90
Average weight per charge	4130 lbs.

On twenty-two scattering occasions the charge was 5120 pounds or 24% above the average and on only two occasions the charge fell to 2562 pounds. On the remainder, or 66 occasions, the charge was uniform at 3843 pounds.

Total batch fed		185.9 tons
Oil burned	8 A.M. Oct. 3 to 8 A.M. Oct. 4	3189 gals (1)
" "	" " 4 " " 5	3221 "
" "	" " 5 " " 6	3211 "
	Total oil for 72 hrs.	9621 "

(1) Gal. at 60°F

In Table II are shown the records of half-hourly oil consumption during the day shifts of the three test days.

TABLE II

RECORD OF HALF-HOURLY OIL CONSUMPTION

Side Burning	Time	Date 10-3-23 (gal.)	10-4-23 (gal.)	10-5-23 (gal.)
R	9:00– 9:30 A.M.	60.5	72.0	70.5
L	9:30–10:00	70.5	71.0	73.5
R	10:00–10:30	65.	64.5	71.5
L	10:30–11:00	67.	70.0	76.5
R	11:00–11:30	64.	64.0	67.0
L	11:30–12. M	69.5	62.5	80.5
R	12:00–12:30	58.5	68.0	71.0
L	12:30– 1:00	65.5	63.5	70.5
R	1:00– 1:30	62.5	64.0	65.0
L	1:30– 2:00	74.5	72.5	76.0

TABLE II (*Continued*)

Side Burning	Time	Date 10-3-23 Gal.	10-4-23	10-5-23
R	2:00– 2:30	64.0	59.0	65.0
L	2:30– 3:00	72.0	74.0	71.5
R	3:00– 3:30	56.5	64.5	66.5
L	3:30– 4:00	65.5	78.5	71.0
Total		915.5	948.	996.
Variation from daily average		1.6%	.8%	6.2%
Average half hourly		65.4	67.7	71.2
Max. variation from mean		13.9%	15.95	13.05
Average half hourly burned on R side		61.6	65.2	68
Average half hourly burned on L side		68.8	70.3	74.2

Table II shows that the total consumption during the seven hours of each day when temperatures, drafts, and gas analyses were recorded is substantially proportional to the total daily consumption except on Oct. 5, when the consumption noted was 6.2% higher than the calculated consumption obtained by multiplying the total daily consumption by $^{7}/_{24}$. A considerable variation is noted among the half-hour periods but the greater part of this is due to the fact that more oil was burned on the left than on the right side of the furnace.

Gals. oil per ton batch	51.8
B.t.u. in fuel per ton batch	8,000,000
" " " " " glass	9,180,000
Rate of working, sq. ft. melting area per ton batch per 24 hrs.	13.4
Reversal period	½ hr.
Age of tank	5 months
Charging interval	45 min.
Duration of test	72 hrs.

Data for Heat Balance

In addition to the data on quantities thermal data are required under the following heads: (1) temperatures, and (2) thermochemical data of the batch.

Temperatures Permanent bare wire thermocouples of suitable material and size were installed at the points indicated in Figs. 1, 2, and 3 for the entire period of the test. The single couples on the top of each regenerator were attached to recorders as well as the single couples in each flue at the immediate outlet of the regenerators.

To obtain the data for calculating the radiation correction at the various points was a task of some magnitude in itself, and this was not done during the test period but at another time. The method described by Henry Kreisinger and J. F. Barkley was employed.[3]

The temperatures in the stack were read with a Leeds and Northrup indicating potentiometer in conjunction with a 20G, Fe-Constantan

[3] "Measuring the Temperature of Gases in Boiler Settings," U. S. Bur. Mines *Bull.*, No. 145.

couple. All of the other instruments were calibrated against this potentiometer. All couples were calibrated by comparison, at three temperatures in a heated iron block with a Pt:Pt-Rh couple which had been previously calibrated at the melting points of Sn, Zn, Ag, and Au.

Before the test period began, extensive observations were made to discover variations of temperatures in the gas stream at points other than that chosen for the permanent couple and in some cases it has

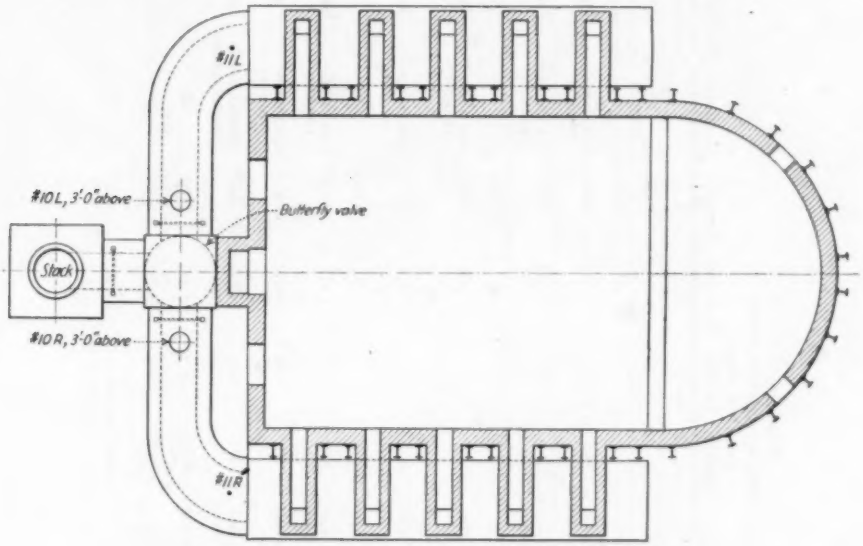

FIG. 1.—Horizontal section "AA" of furnace tested.

been thought justifiable to apply a "location correction." It is obviously improbable that uniform temperatures would prevail in any given cross-section of a highly heated gas. It is equally impractical to devise any means for measuring an accurate average temperature over any cross-section. The most that can be done is to choose the seemingly most suitable location for the permanent couple and then by means of exploration and simultaneous readings in the plane of the permanent couple to arrive at an approximate correction. This same method has been employed for approximating temperatures in the gas stream in cross-sections ahead or behind the permanent couple.

The original observations of temperatures in the top of the regenerator and in the flue are in the form of time-temperature curves taken from the recorders. These are illustrated in Fig. 4. The mean temperature of each cycle is estimated by eye and the average of all these estimations for the 72-hour test period gives the average original

TABLE III

TEMPERATURES DURING TEST PERIOD

(Oct. 3 to 5, 1923)

Number of point from Figs. 1, 2, 3, 3a	Location of thermocouple or thermometer	Description of couple or thermometer	Average indicated temp. °F	Location (4) correction °F	Radiation correction °F	Average true temp. °F	Number of observations	Max. variation from average °F	Time and period of observation
1R	Glass in melting end	L. & N. Morse type optical pyrometer				2490	9	10	(1) During day shift
1L									
2L	Glass in melting end in a burner port	No. 8 gage bare CrAl couple				2424	1		
3R	(2) Top of right regenerator heating	Couple No. 10, No. 8 gage CrAl bare couple diam. couple bead .259 in.	1805	+29	+468	2302	Continuous recorder	180	Entire test except 24 hr. when couple burned out
4L	Top of left regenerator heating	Couple No. 16 bare couple No. 8 gage CrAl diam. couple bead .258 in.	1727	+29	+468	2224	Continuous recorder	53	Entire test
	Av. right and left top of regenerator heating					2263			
3R	(3) Top of right regenerator cooling	Couple No. 10, No. 8 gage CrAl bare couple diam. couple bead .259 in.	1643		−100	1543	Continuous recorder	54	Entire test except 24 hr. when couple burned out
4R	Top of left regenerator cooling	Couple No. 16, No. 8 gage CrAl bare couple diam. couple bead .258 in.	1617		−100	1517	Continuous recorder	50	Entire test
	Av. top right and left regenerator cooling					1530			
5R	Right flue at exit from regenerator heating	Couple No. 43, No. 14 gage iron constantan bare couple diam. bead .130 in.	938	−36	+171	1073	Continuous recorder	54	" "
5L	Left flue exit from reg. heating	Couple No. 22, No. 14 gage iron cons. diam. bead .133 in.	902	−50	+171	1023	Continuous recorder	54	" "
	Av. flue					1048			
6	Stack	Couple No. 20, No. 22 gage iron constantan bare couple diam. bead .05 in.	574	−12	(5)	562	120 with L. & N. potentiometer	56	During day shift in test period
	In burner port R3 heating	Couple No. 15, No. 8 gage CrAl bare couple diam. .130 in.	2012		+611	2623	20		(6) During one reversal cycle of 1 hr.
	Same cooling	Same	1778		−135	1643	20		"
7	Temp. of brick n burner port heating	Couple No. 36, No. 14 gage CrAl bare couple	2070			2070	20		"
7	Same cooling	Same	1827			1827	20		
8	Checker brick top of regenerator heating					(7) 1917			

TABLE III (*continued*)

TEMPERATURES DURING TEST PERIOD

(Oct. 3 to 5, 1923)

Number of point from Figs. 1, 2, 3, 3a	Location of thermocouple or thermometer	Description of couple or thermometer		Average indicated temp. °F	Location (4) correction °F	Radiation correction °F	Average true temp. °F	Number of observations	Max. variation from average °F	Time and period of observation
8	Checker brick top of regenerator cooling						(7) 1767			
9	Checker brick bottom of regenerator heating						(7) 782			
9	Checker brick bottom of regenerator cooling						(7) 487			
	Temp. of secondary air entering regenerators						(8)			
	(9) Temp. of primary air for atomizing	Mercury thermometer					223	35	Negligible	During day shift in test period
	Temperature of oil	"	"				164		"	
	Temp. of cold cooling water	"	"				66.2		"	
	(10) Temp. of hot cooling water	"	"				104.	16	"	During day shift in test
10	Temp. of secondary air in 18 in. pipe	"	"				73.5			
	Av. wet bulb temp.						61.3			
	Av. dry bulb temp.						69.4			

NOTES

(1) A Pt:Pt-Rh couple inserted through the crown over the bridge wall of the furnace and connected with a recorder showed a practically uniform temperature throughout the test.

(2) Heating refers to heating of checker brick by the gases of combustion.

(3) The period of cooling is when air or producer gas is passing through the regenerators.

(4) The application of this correction which was obtained by exploration makes the observed temperature at the point of the permanent couple concordant with the average temperature of the gas flowing through that cross-section.

(5) The stack is lined with brick and the flow of gas is constant. Under these conditions at this low temperature no important radiation correction need be expected and no determination was made.

(6) Conditions in the burner port do not lend themselves to continuous routine observations. Readings were therefore made during one-hour period with several sizes of couples to obtain the radiation correction and the fall in gas temperature and rise in air temperature respectively between this point and the top of the regenerator noted and it was then assumed that this respective fall and rise held constant during the test period. What error if any is introduced by this assumption is very small.

(7) The temperatures of brick work in the regenerator are the result of a special investigation details of which are not given. The figures are the average of a large number of readings from end to end and top to bottom of the regenerator.

(8) No temperatures of cold air entering were taken at this point. The average will be only a little above that of the outside air, since most of the heat in the flue brick work is abstracted during the first few minutes after reversal.

(9) Taken near orifice meter in distributing line.

(10) Taken at weir.

temperature reading. To this is then applied the couple correction and the instrument calibration to give the true *indicated* temperature. Next are applied the radiation and location corrections, giving the *true temperature.*

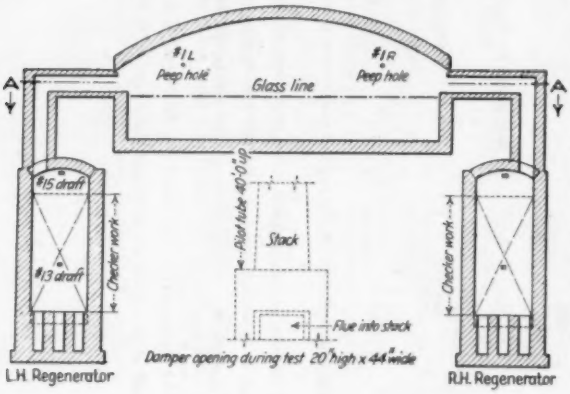

FIG. 2.—Cross-section of furnace tested.

The temperature of the glass was obtained by sighting a Morse type optical pyrometer at the angle of bath and furnace wall at a point about midway along the tank during the short interval between reversals when the furnace atmosphere was clear. This reading was also roughly checked by inserting a thermocouple in the glass.

The temperature observations are summarized in Table III. The most noteworthy feature of these data is the great magnitude of the radiation correction when hot gases are flowing through passages lined with cooler brick work. It is obvious that heat-balance calculations which ignore the radiation correction are inaccurate.

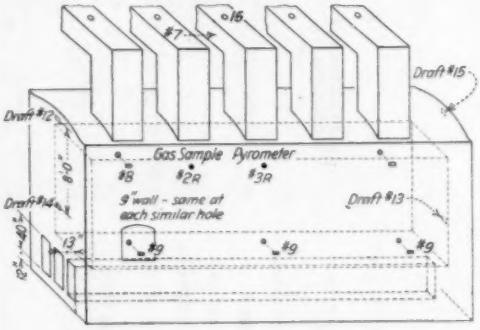

FIG. 3.—Oblique projection. Right hand regenerator of furnace tested.

At best, with temperature conditions substantially constant in any given flue cross-section, the method of Kreisinger and Barkley for determining radiation correction is laborious because of the difficulties encountered in extrapolating the couple size *vs.* temperature curves to zero size couple; and the difficulty is greatly increased in readings taken in regenerators by the necessity for applying a time correction caused by the regular variation of temperature with time at any given point in the gas stream. A preferable method is the high gas velocity couple of Haslam and Chappell.[4]

[4] R. T. Haslam and E. S. Chappell, "The Measurement of the Temperature of a Flowing Gas," *Bull. Mass. Inst. Tech.*, **60**, No. 81, May, 1925.

This couple could be employed for direct reading of true temperature at any point in the regenerator system.

Heat in the Glass In calculating the heat in the glass, we take the observed temperature of the glass in the melting end of the furnace, which is presumably the same as the temperature of the glass passing through the submerged port in the bridge wall which separates the pool of glass in the melting end of the furnace from the pool of glass in the working end, from which the glass is fed to the machines. The latter pool is virtually a crucible and the furnace proper or melting end should be credited with the heat in the glass entering this crucible and not with the heat in the glass leaving the crucible and entering the machines. The loss of heat in the working end or crucible is properly chargeable to the operation of working the glass and not to the operation of melting and fining it. The working end of the furnace has sometimes been referred to as the fining end, the inference being that the pool of glass is subjected to a fining action. This, however, is a misnomer, because the fining is completed as the high temperature prevailing in the melting end of the furnace and the viscosity of the cooler glass in the working end is too great to permit any important additional amount of fining action if we mean by fining the release from the glass of the gaseous products of decomposition.

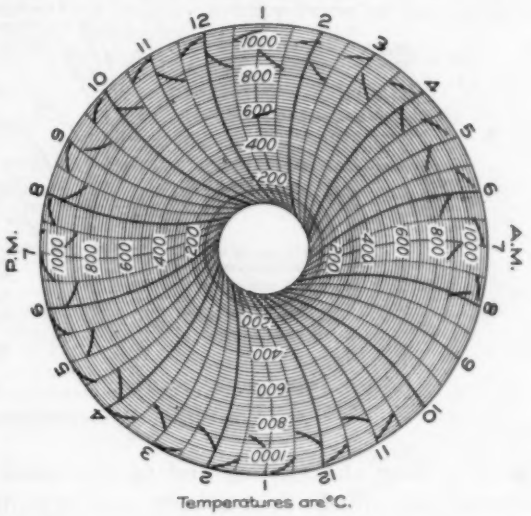

FIG. 4.—Recorder chart. Top of right regenerator.

The more rational view, therefore, seems to be to look upon the pool of glass in the working end as a forebay or supply reservoir in which the temperature is lowered to a sufficient degree to satisfy the requirements of the automatic machines, and as having an essentially different function from the melting end of the furnace.

It is possible, as pointed out by W. L. Baillie[5] that there is a

[5] William L. Baillie, "An Examination and Extension of Zulkowski's Theory of the Relation between the Composition and Durability of Glasses," *Jour. Soc. Glass Tech.*, **6**, 68 (1922).

molecular rearrangement at the cooler temperature of the glass in the melting end which has a bearing on the quality of the finished product, but we may look upon this as a "crucible" rather than as a "furnace" reaction.

It is true that the gas space is continuous over both ends of the furnace, but if the cap over the working end be insulated, which is entirely feasible and proper, the bridge wall can be raised a corresponding distance above the level of the glass, so that the amount of heat

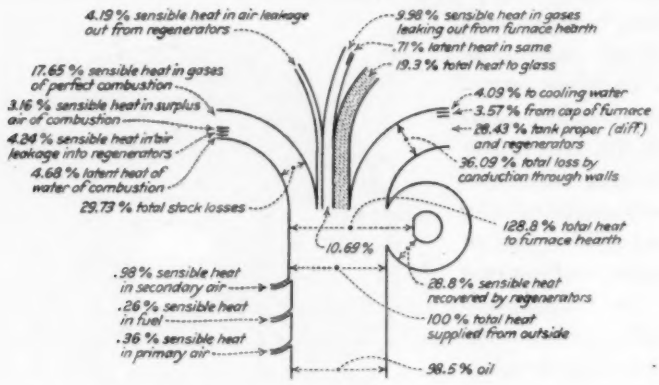
4.19 % sensible heat in air leakage out from regenerators
17.65 % sensible heat in gases of perfect combustion
3.16 % sensible heat in surplus air of combustion
4.24 % sensible heat in air leakage into regenerators
4.68 % latent heat of water of combustion
29.73 % total stack losses
9.98 % sensible heat in gases leaking out from furnace hearth
.71 % latent heat in same
19.3 % total heat to glass
4.09 % to cooling water
3.57 % from cap of furnace
28.43 % tank proper (diff.) and regenerators
36.09 % total loss by conduction through walls
128.8 % total heat to furnace hearth
10.69 %
.98 % sensible heat in secondary air
.26 % sensible heat in fuel
.36 % sensible heat in primary air
28.8 % sensible heat recovered by regenerators
100 % total heat supplied from outside
98.5 % oil

FIG. 5.—Heat balance of continuous oil-fired glass tank furnace making flint glass for bottles.

passing from the melting end to the working end by radiation and convection through the gas body may be reduced to a minimum.

The glass made in this furnace is a bottle glass and calculations based upon the best available thermochemical data give:

Total heat per lb. of glass at 2490°F, including heat of decomposition and after crediting heats of formation	899 B.t.u.
Ignition loss of batch	12.8%
Per cent CO_2 in batch	10.9%
Per cent H_2O in batch	1.9%

Dust losses from the batch are very small and are not given consideration in our calculations.

Specific Heats of Gases The following values for mean specific heats at constant pressure are taken from Kuzell & Wigton[6]

$$H_2 = 3.3381 + .0001240t$$
$$O_2 = 0.2111 + .0000087t$$
$$N_2 = 0.2411 + .0000099t$$
$$CO = 0.2413 + .0000099t$$
$$CO_2 = 0.1975 + .0000388t - .0000000043t^2$$
$$H_2O = 0.4701 - .0000118t + .0000000127t^2$$

[6] *Trans. A.I.M.E.*, 49, 774.

In these expressions t is in °F and the specific heat in B.t.u. per lb. per °F.

Cooling Water Some cooling water was used and this was measured over a V-notch weir and its temperature rise noted.

Heat Balance From the foregoing and from the additional data on quantities in the paper by the senior writer referred to before, the complete heat balance is constructed and set forth in the following Table IV.

TABLE IV

HEAT BALANCE OF COMPLETE FURNACE SYSTEM BETWEEN PORTS AT BOTTOM OF REGENERATORS (B.t.u. per ton glass)

(Rate of working, 13.4 sq. ft. of melting area per ton of batch per 24 hours)

	Debit	Credit	Per cent
Combustion heat of fuel	9,180,000		98.5
Sensible heat in primary air above 60°	33,500		.36
Sensible heat of fuel above 60°	24,200		.26
Sensible heat in secondary air as delivered to bottom of regenerators above 60°	91,300		.98
			100.
Total heat to glass, chemical and sensible, above 60°F		1,800,000	19.3 (efficiency)
Sensible heat in gases of perfect combustion including CO_2 and H_2O from charge as delivered to flue above 60°		1,645,000	17.65
Sensible heat in surplus air of combustion as delivered to flue above 60°		295,000	3.16
Sensible heat in air leakage in regenerators during period of heating brick as delivered to flue above 60°		396,000	4.24
Sensible heat in air leakage outwardly from regenerators during heating air above 60°		391,000	4.19
Sensible heat of gases of combustion leaking outwardly from hearth above 60°		930,000	9.98
Latent heat in same		66,000	.71
Latent heat in gases delivered to flue		436,000	4.68
Estimates loss from cap of furnace to atmosphere by radiation, conduction and convection		333,000	3.57
Loss to cooling water		381,000	4.09
Difference including all errors and all losses not specified, principally from tank proper to atmosphere		2,656,000	28.43
	9,329,000	9,329,000	100.

The heat balance is shown diagrammatically in Fig. 5.

It should be pointed out that the heat balance of the furnace is correct only for the stated rate of working. The fuel economy of the glass tank furnace, in common with the open-hearth steel furnace, is greatly improved by increasing the rate of working, but the rate of working of a glass tank furnace will usually depend upon the demands of the automatic machines and occasionally these "draw" the tank up to the limit of its fining or what may be termed its metallurgical capacity. It so

happens that this furnace was working at about its maximum fining capacity, but considerably greater rates of working have been noted in other furnaces. It may be stated that fuel consumption per ton of output in open-hearth regenerative furnaces is more favorably affected by increasing output than by any other one factor, but that other important possibilities for fuel economy exist is made evident by Table IV.

Possible Savings of Fuel

These possible savings are summarized approximately as follows:

	B.t.u. per ton glass
By reducing surplus air for combustion by better methods of combustion control	147,500
By reducing leakage outwardly of gases of combustion from the roof and walls of the furnace. (Method of attack doubtful but saving of 40% is estimated.)	400,000
By reducing regenerator leakage	395,000
By insulating regenerators	350,000
Total	1,292,500

This corresponds to a reduction of 14% of the total fuel burned.

In a general way the same method of analysis may be applied to any furnace of the open-hearth regenerative type with a beneficial addition to the knowledge of preventable losses of fuel.

In steel furnaces it probably would be impractical to insulate the roof and it was formerly thought to be impractical to do this in glass tank furnaces, but some work of the writers[7] proved that the temperature of the inside of the roof brick was controlled, not by flow of heat through the brick, but by the temperature of the furnace bath and as this was slightly below 2500° the silica brick were not damaged by application of insulation although they became incandescent throughout their length.

Probably the principle fact brought out by this heat balance is that leakage through furnace brickwork is as prolific a source of heat losses as flow of heat through them by conduction.

Acknowledgments Acknowledgments are due to Kenneth M. Henry and P. D. Burtt, for valuable assistance and advice throughout this work.

4068 Holden St.
Emeryville, Calif.

[7] Robt. D. Pike, "The Insulation of Roofs of Metallurgical Furnaces," to be published in this *Journal*.

NOTES ON FIRING TERRA COTTA[1]

By Samuel J. McDowell and Remington M. Murphy

ABSTRACT

Some notes are given on the firing behavior of a 14-foot diameter muffle type terra cotta kiln, using coal as a fuel. The need of more data on periodic fired kilns in all branches of the ceramic field is stressed.

Introduction

Approximately 80% of the factory cost of terra cotta has been expended on ware by the time it reaches the kiln. This makes kiln firing a matter of marked importance.

The chief objects, therefore, of a factory investigation on firing are: (1) improvement of product, (2) decrease in fuel required, and (3) decrease in time required.

In order to work toward these goals intelligently the study of the behavior of a kiln under fire is necessary.

The Bureau of Mines has made enlightening studies of actual plant firing conditions on certain types of heavy clay ware[2] and refractories[3] and this was made the basis for the present problem. The investigation of the Bureau was conducted by six men in the field as well as a laboratory force. Special apparatus, not usually accessible to a plant, was used. The Bureau of Mines investigation did not include terra cotta muffle kilns and there are little or no data to be found in ceramic literature regarding the firing of terra cotta.

The muffle kiln is notably less efficient as the heat must be carried by conduction through the muffle wall before it can be transmitted by convection and radiation to the ware within. It is also difficult to carry through the oxidation period efficiently as the passage of a large volume of heated air advocated by the Bureau of Mines is impossible. The air stream, in contact with the ware, is free from products of combustion as it is usually admitted through peepholes near the bottom of the kiln and allowed to escape through one or more holes in the crown. This air is cold, however, and retards heating up the ware. Fortunately most terra cotta bodies are not difficult to oxidize or this phase might be serious.

Tests Made

The tests consisted of making readings on a 14-foot periodic coal-fired muffle kiln firing terra cotta.

A first firing was made with conditions as normally prevailed in the

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Terra Cotta Division.) Received July 14, 1928.

[2] "The Burning Problems of Industrial Kilns," Bur. Mines, Report to Four Heavy Clay Associations.

[3] "Problems in Firing of Refractories," Bur. Mines, *Bull.*, No. 271.

plant. The results were studied, certain changes were mapped out, and other runs made observing the effect of these changes.

Type of Kiln

The type of kiln used in all the tests is shown in Fig. 1.

The measurements and ratios are as follows:

Inside diameter of kiln	14 ft.	Grate area per fire box	4.7 sq. ft.
Total kiln area	154 sq. ft.	Number of fire boxes	12
Height to spring of crown	11 ft. 6 in.	Total effective grate area	56.4 sq. ft.
Height to top of crown	18 ft.	Ratio of grate area to total kiln area	36.6%
Contents of kiln available for setting	2002 cu. ft.	Ratio of grate area to cubical contents of setting	2.1%
Thickness of muffle wall	$4\frac{1}{2}$ and $2\frac{1}{2}$ in.	Flue area (up sides of kiln)	7 sq. ft.
Thickness of kiln wall (to wall flue)	$29\frac{1}{2}$ in.	Area of stack at exit into cone	2.5 sq. ft.

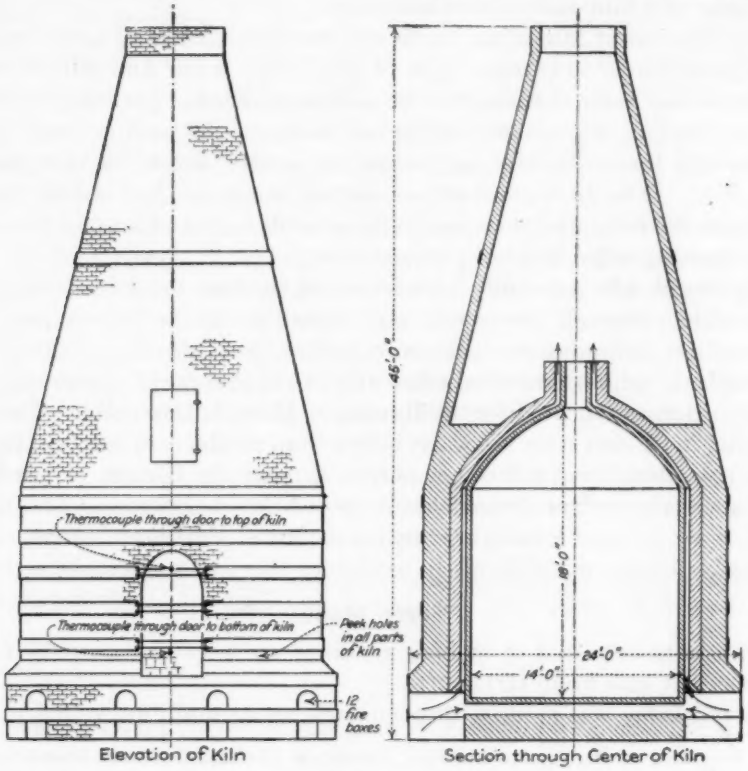

FIG. 1.

In comparing these figures with those of the firebrick kilns in the refractories investigation of the Bureau of Mines the ratio of grate area

to kiln area seemed to be unusually high but when this area was compared with the cubical contents of the setting which was perhaps a better guide, it did not appear so abnormal. It was, however, somewhat higher in both cases than the same relations figured approximately from the slightly larger kiln described by A. F. Hottinger.[4]

As will be noted, there was no center stack in this type of kiln. The floor flues went into the center of the kiln and then lead out to the wall flue and were built slightly higher than the fire boxes. It seemed probable, however, that little or no products of combustion were drawn through this circuitous channel when the way was open for a straight updraft movement and that these flues were heated almost entirely by radiation from the fire boxes.

The furnaces were of the horizontal grate type and were equipped with fireclay slab doors which fitted more or less tightly.

The coal used was of the Pennsylvania bituminous variety having the following analysis:[5]

	Per cent		Per cent
Ash	8.0	Volatile	36.3
Sulphur	1.2	Fixed carbon	54.6
Moisture	1.1	B.t.u. = 14,150	

The kiln as normally used was equipped with a thermocouple which extended three inches into the muffle at a height of seven feet from the floor. This couple was protected by a fireclay tube $1\frac{1}{2}$ inches thick. Readings from this couple were automatically recorded and were also read hourly from an indicating pyrometer.

Apparatus Used

Chromel-alumel thermocouples extending in to the center of the kiln were inserted on both the top and bottom slabbing. In the former case the bead was at the top slab level, while in the latter cases the bead was three inches from the kiln floor. The readings therefore, showed the rate of heating of a piece of ware in the center of the kiln on the top and bottom of the setting. The cold junctions were just outside the kiln door. Their variations in temperature as the kiln became hotter were compensated for in the readings. These were taken on a portable indicating pyrometer which had just been calibrated. There was an error introduced by the wire leading to the instrument but this was constant in all the runs.

Draft readings were made with an inclined draft gage and the tubes used for this and also for drawing the gas samples to be analyzed, were

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[4] A. F. Hottinger, "Data on the Northwestern Terra Cotta Kiln," *Trans. Amer. Ceram. Soc.*, 9, 684 (1907).

[5] Analyses by courtesy of the Pittsburgh Coal Co., Pittsburgh, Pa.

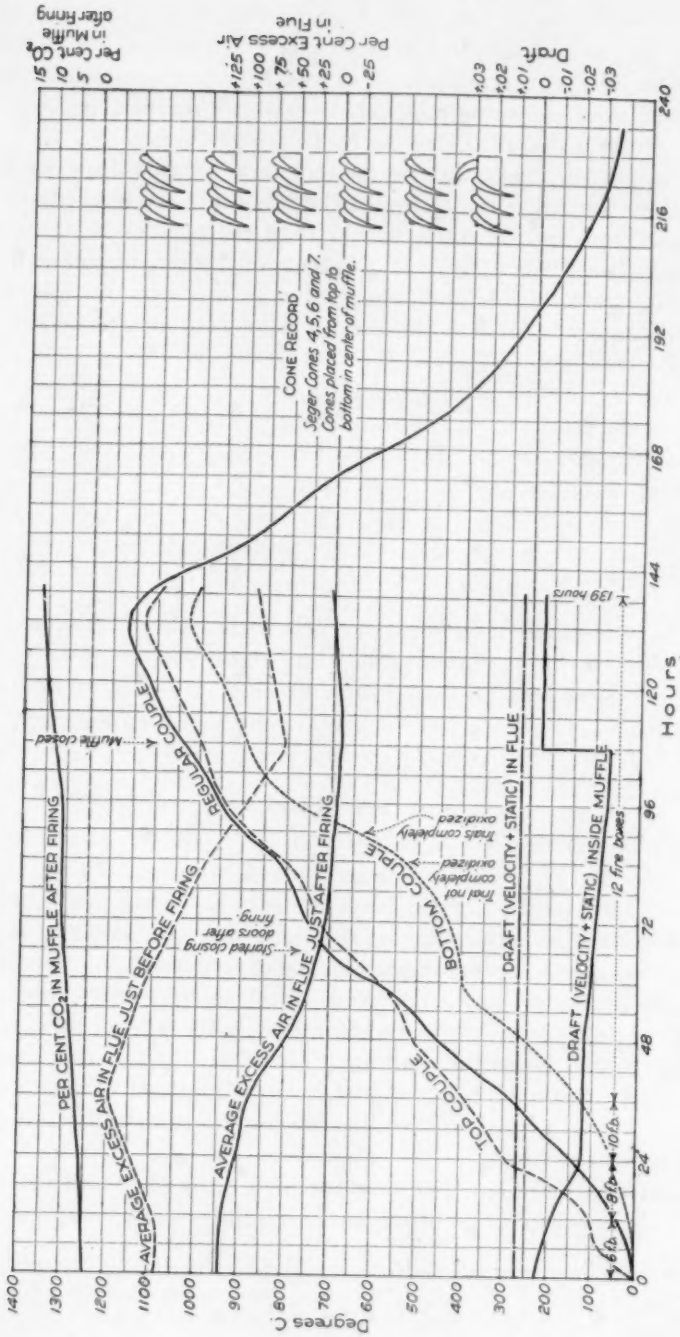
Per Cent CO2 in Muffle after Firing
Per Cent Excess Air in Flue
Draft
CONE RECORD
Seger Cones 4, 5, 6 and 7.
Cones placed from top to bottom in center of muffle.
PER CENT CO2 IN MUFFLE AFTER FIRING
AVERAGE EXCESS AIR IN FLUE JUST BEFORE FIRING
AVERAGE EXCESS AIR IN FLUE JUST AFTER FIRING
Muffle closed
Y COUPLE
REGULAR
Started closing doors after firing.
BOTTOM COUPLE
That not completely oxidized
That completely oxidized
TOP COUPLE
DRAFT (VELOCITY + STATIC) IN FLUE
DRAFT (VELOCITY + STATIC) INSIDE MUFFLE
12 fire boxes
139 hours
6 lb.
8 lb.
10 lb.
Degrees C
Hours

FIG. 2.—Firing number 1.

of fused quartz. One was installed three inches inside the muffle and another inserted into the center of the wall flue.

Gas samples were drawn into a water-sealed bottle. Approximately three minutes were consumed in taking each sample so that each analysis was the average of the gas over that period of time. Analyses were made for CO_2, O_2 and CO by means of an Orsat apparatus.

An attempt was made to determine at what time during the firing the chemically combined water had been driven off. A piece of ware was suspended by a nichrome wire at the level of the lower thermocouple. The wire was attached through the crown hole to a balance above the crown of the kiln. The effort was not successful due to the heat developed in the cone before the water was eliminated.

First Run

Firing The kiln was started by lighting six fire boxes. The lighting was increased by two each twelve hours so that all twelve were lighted at the end of 36 hours. The doors were left open for 60 hours but they were closed immediately after firing. The kiln was from that time on fired at intervals of $1\frac{1}{4}$ to $1\frac{1}{2}$ hours. The fires were broken up with a bar twice each 12 hours. A dark cloud of smoke followed each firing lasting about 15 minutes, and gradually becoming lighter. The center hole in the crown was closed at the end of 108 hours and firing was stopped at the end of 139 hours. The results are shown in Fig. 2.

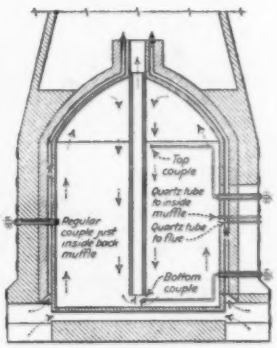

FIG. 3.—Section through door, showing inside stack.

Temperature The top of the kiln heated rapidly but the bottom lagged and at the end of 72 hours it was almost 300°C behind. This difference gradually decreased to 100°C when the kiln was finished.

Draft There was no noticeable change in the draft (velocity+static) in the flue. This remained at +.004. The draft in the muffle, however, gradually increased from −.004 to −.035. When the muffle was closed it immediately dropped to −.004 and remained constant for the remainder of the firing. There was, at the point where the readings were taken, a positive pressure in the flue and a negative pressure within the muffle at all times.

Gas Analyses There was a large excess of air in the flue during the early stages, varying from 100% after firing to 250% when the fires were well burned out. This decreased as the fuel bed grew thicker and the doors were closed. From this time on there was

little or no excess air after firing and often a deficiency. Just before firing, however, there was an excess of approximately 75%.

Inside the flue there was at no time any CO present but the amount of CO_2 increased from 0 to 11%. This is probably due early in the firing to the carbonaceous matter in the ware as well as from products of combustion leaking in. Later it was undoubtedly caused almost entirely by leaks.

Discussion From the results obtained it was felt that there was an abnormal difference between the rates at which the top and bottom centers of the kiln heated up. If any attempt was made to speed the firing, this condition would be made worse rather than

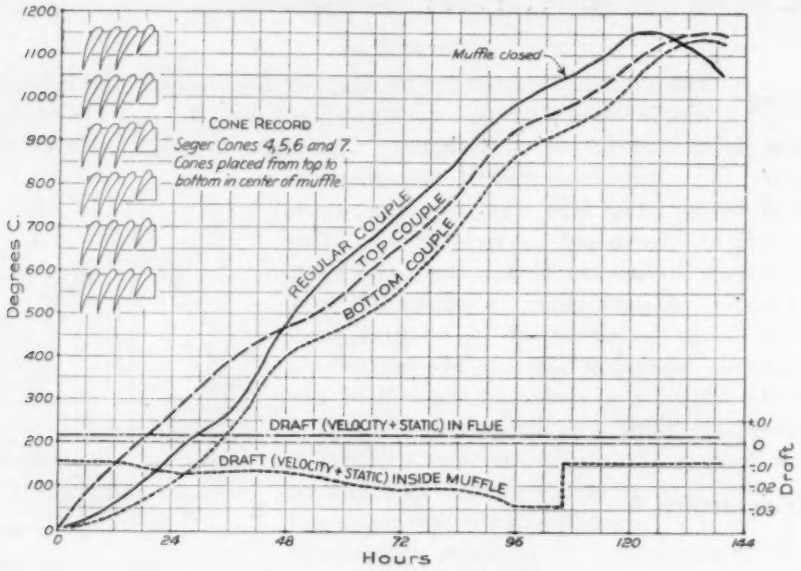

FIG. 4.—Firing number 2.

better. This temperature difference while not showing markedly in the cones or ware where the firing time was long, would make itself felt if the process were speeded.

Second Test

It was decided to insert a stack as shown in Fig. 3. This was pressed out of terra cotta clay in the form of a pipe 2 inches thick, 18 inches high, and 18 inches in diameter. It was raised 8 inches from the floor of the kiln. This in reality made a downdraft muffle. One 24- by 24-inch slab was left out in all the sections to allow a passage of air down around the stack. This made a loss of 4% of the setting space but it was felt that uniformity of heat distribution would make up for the loss.

A firing was made to check the effect of the stack. No other changes were made and temperature and draft readings only were made. The results are shown in Fig. 4. The kiln finished in 130 hours. As will be noted the top and bottom couples were never more than 100°C apart and when the kiln finished were only 15°C apart. The cones showed the firing to be quite uniform.

Third Test

This firing was made in an effort to lower the firing time. An extra slabbing was used over a portion of the top to give a greater tonnage to the kiln. This amounted to an increase of about 7%. The proposed curve was laid out but could not be followed exactly. The results are shown in Fig. 5.

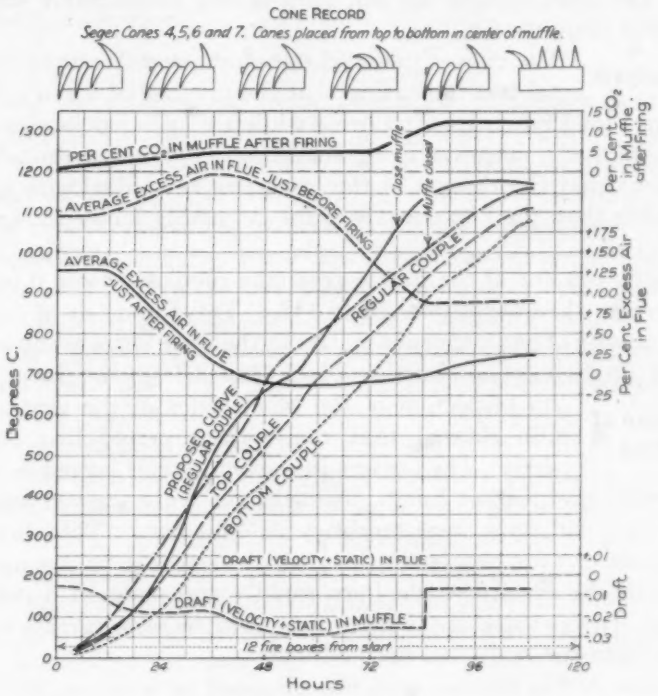
CONE RECORD
Seger Cones 4,5,6 and 7. Cones placed from top to bottom in center of muffle.
PER CENT CO2 IN MUFFLE AFTER FIRING
AVERAGE EXCESS AIR IN FLUE JUST BEFORE FIRING
AVERAGE EXCESS AIR IN FLUE JUST AFTER FIRING
Close muffle
Muffle closed
REGULAR COUPLE
PROPOSED CURVE (REGULAR COUPLE)
TOP COUPLE
BOTTOM COUPLE
DRAFT (VELOCITY+STATIC) IN FLUE
DRAFT (VELOCITY+STATIC) IN MUFFLE
12 fire boxes from start
Degrees C.
Per Cent CO2 in Muffle after Firing
Per Cent Excess Air in Flue
Draft
Hours

FIG. 5.—Firing number 3.

Firing All twelve fire boxes were lighted at once and the temperature raised as near the proposed curve as possible. Four shovels of coal were put on each fire at the end of 8 hours and as a result the fires smoked rather badly. At the end of 28 hours the doors were partially closed 30 minutes after firing. At the end of 48 hours the doors were left open for 15 minutes and then closed completely. This practice

continued to the end of the firing and eliminated some smoke, although the deficiency of oxygen remained about the same as in the first run.

At the end of 56 hours, trials pulled from the kiln showed complete oxidation and from this point on the temperature was raised as fast as possible. The vent hole in the crown was closed at the end of 85 hours and firing stopped at the end of 110 hours. The fires were cleaned as in the previous run and there was no attempt at alternate firing due to the smallness of the kiln.

Temperatures The top and bottom both lagged behind the regular couple but stayed within 75°C until about 700°C when they were 140° apart. The lines gradually converged and were 35°C apart at the finish.

Draft The draft reading did not vary in any considerable way from the original test.

Gas Analysis The curves followed the same general form as the original test indicating that the practice of leaving the kiln doors open for 15 minutes after firing while aiding in smoke elimination did not markedly improve firing conditions. This was probably due to the fact that the throats of the fire boxes were filled with coal and this, rather than the kiln doors was the governing factor in regulating the oxygen.

The CO_2 content of the muffle gradually increased from 0 to 5% in 72 hours and then rapidly raised to 11%. This could not be explained by the burning of carbonaceous matter in the ware but was the accumulation of products of combustion which leaked from the flue.

Discussion of Third Test An inspection of the blind cones in the center of the kiln showed that the soaking period had been too short. The bottom in particular had lagged as was expected with the quicker firing. None of the ware showed any black coring but it did show some tendency to "spit out." This was due to the presence of a fire clay in the body which carried some coal and small pieces near the surface would burn rapidly and scale off a portion of the ware. It was therefore thought unsafe to decrease further the time of firing until the body had been adjusted.

The coal used in the two tests was obtained by weighing the coal on wheelbarrows and counting the wheelbarrows used.

	1st Test	3rd Test
Tons terra cotta	21.2	22.0
Tons coal	21.2	20.1
Tons ashes	2.0	1.8

No conclusions were drawn except that a stack inside the muffle where there is no center stack to the kiln markedly improves top and bottom variation.

CORNING TERRA COTTA COMPANY, INC.
CORNING, N. Y.

CONTINUOUS AND PERIODIC ELECTRIC DECORATING KILNS[1]

By J. R. Eves

ABSTRACT

Detailed descriptions are given of electric decorating kilns, one of a continuous type installed at the Buffalo Pottery Co., of Buffalo, N. Y., and two of the periodic type installed at the Smith Ceramic Studios of Rochester, N. Y. Construction, equipment, and operation details are given. Advantages of these kilns over other kinds more commonly used are discussed.

Introduction

The major cost in pottery making comes before the ware reaches the decorating kiln; therefore, losses sustained in decorating are of the greatest consequence and the special cost of the necessary equipment is of less consequence.

The Kiln

A continuous decorating kiln was designed and installed in the plant of the Buffalo Pottery Company. The general design of this kiln is similar to all continuous kilns with the return track, the transfer track, sand seal on the car, and baffles to prevent draft between the cars. The kiln has overall dimensions of 62 ft. long, 5 ft. 6 in. wide, and 5 ft. high, and was designed for a capacity of 3000 dozen average pieces per week, and to have 18- to 24-hour operating cycles, depending on plant conditions, so as to allow as much flexibility as possible. The kiln is used in both hardening overglazed and underglazed decorating work and gold lining. Since March 15, 1927, it has been caring for their plant production.

The cars are 30 in. wide, 54 in. long, and 10 in. high at the loading space. The kiln has accomplished 4000 dozen pieces per week and has run in its minimum schedule of 2000 dozen per week.

The furniture was the same as previously used in a coal-fire decorating kiln such as many potteries use.

The operating temperature of this kiln is cone 012 down, cone 010 started. Quite a bit of heat-resisting alloy furniture has been put into service and is very satisfactory.

Labor Required

The labor required to load and unload the furnace and sort the ware is four men, two in one shift, and one for each of the other eight-hour shifts. The losses, traceable to the electric kiln, according to the management, have been exceedingly low, or practically negligible.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (White Wares Division.)

Burning Off of Size

An interesting discovery was made in that the burning off of size, which gave promise of being a problem, was not at all troublesome, except for condensation in the pipe. The pipe requires an occasional cleaning, but there have been no smudged ware from the kiln.

Pusher

In this kiln the pusher is a continuous chain which carries the car for slightly over one car length, so that the last car in the kiln pushes the load ahead of it. This pusher is underneath the kiln, gearing and all are inclosed, and it is driven by an electric motor through a compound worm gear mechanism.

Refractories Used

Another construction feature of this kiln which is very noteworthy is the fact that the only fire brick used in its construction are those in the primary section of the cooling zone, which is made with a $4^1/_2$-inch firebrick arch roof, and a 9-inch firebrick wall. The secondary section of the cooling zone is made up of asbestos transite while the entire heating zone and the floors of the car are made of insulating material, super brick, Sil-O-Cel, and Sil-O-Cel Natural.

Control

This kiln is not equipped with a pyrometer and is operated fully on an average load temperature basis, with the time element controlled by the pusher.

The electric units which will be spoken of more fully, are arranged in six circuits, and are connected in a balanced way to a three-phase line, so that each phase is the equal of another one within $\pm 5\%$, this being the allowable variation granted by the power company. The first two sections of this furnace, or the preheating and firing-off zone, are controlled in temperature solely by secondary switches. These switches have an adjustable voltage from the transformers of from 90 to 115 and allow quite a range for adjustment within the natural fluctuation of the line voltage.

The final or high-temperature zone in this furnace has an automatic voltage regulator in the nature of the ordinary induction regulator on the high tension side of the transformer, which holds the load in that section plus or minus one-half kilowatt, so that any external voltage change does not affect the kiln and is compensated for automatically.

From a check-up of the temperature of the kiln with a pyrometer, over a long period of time the maximum fluctuation was found to be 15°F, which for commercial use is very close.

There are twenty units in this furnace, each unit being four feet long by ten inches wide. With this installation the lighting scheme for the room, the power for the pusher, and the energy for the furnace all come from one incoming power line, so that if the power is off the furnace pusher stops and the ware is held back until such time as the power is put on.

This furnace has been shut down for one periodic cleaning and inspection and the interior then looked as good as the day it was completed.

It is of interest to note that the kiln required only twenty-four hours heating-up period to go into full scheduled production from dead cold shut down.

Power Used

From the angle of the electric power serving company this kiln is an exceptionally good load, having unity power factor, exceptionally high load factor, with automatic control of load. The kiln has a connected load of 90 kilowatts on a capacity of 3000 dozen per week, or 70 kilowatts on a capacity of 2000 dozen per week, and the consumption for firing one average dozen in .5 kilowatt hours, or at a rate of 2250 dozen per week, the kilowatt hours consumed per day are 1670 per 24-hour day operation. The power company probably will make an exceptional rate for a power load of this kind, due to its acting as a fly wheel on their equipment and steadying their entire load. Equipment of this nature, naturally affects the rate at which the consumer purchases the rest of the power for his plant.

Adaptability to Product Flow

One of the additional advantages of this kiln is the fact that it can be placed in direct line of production eliminating much handling. It could be placed on the second floor of a plant as there is absolutely no fuel storage or ventilation for burners required, the air in the room is not vitiated, and no exceptional headroom for the kiln is needed.

Those interested in ceramic art have inquired whether there is a circulation of air in this kiln or if the heat is transferred through the medium of radiation. It would be ideal if the heat could be entirely transferred through radiation, but such is not the case.

Heat Transfer

The initial part of the temperature is such that the major amount of heat is transmitted by convection; this convection is controlled so that the cavity underneath the cars produces the longitudinal flow of air toward the cooling end, and it returns above the car and around the ware. This return travel of air from the cooling end to the heating end,

carries a sum of heat from the high temperature zone into the preheating zone. This same heat is made useful in transferring size as it is fired off to the ingoing end of the kiln. This is the reason why there is no smudging.

Electric Periodic Kilns

Electric periodic kilns are used to decorate vases, tea sets, percolators, casseroles, ovenware, etc. They had previously used gas-fired decorating kilns. When required to increase their furnace capacity, and no further floor space was available, two electric periodic kilns were installed, which increased their capacity 125%.

The inside dimensions are 3 ft. wide, 3 ft. high, and 5 ft. deep in the loading space, having 45 cubic feet of ware. They occupy floor space 7 ft. by 5 ft. and require approximately 11 ft. of head room. They have a connected load of 42 kilowatts, 3-phase, 220 volts, 60 cycles, and do not require any transformers installed with them. These kilns also have a unity power and are a noninductive load. The electrical units are flat type resistors and are placed on three sides in this particular installation.

These units are arranged to give a low heat with 22 kilowatts and a high heat of 42 kilowatts by means of a double-throw switch; all units are in operation under either condition.

The watt density on these units, like those previously mentioned, is five watts per square inch of unit surface.

By watt density is meant the amount of energy in the form of heat the unit must dissipate. With a watt density of 5, the unit is called on to radiate or dissipate 17.06 B.t.u per hour or .2843 B.t.u. per minute per square inch of unit surface. In this case the unit approaches a black body condition with a high rate of emissivity. This produces a unit with a very small temperature difference between the temperature of the unit itself, and the ware being heated. For the reasons before stated, the life of these units is very long, and cost of renewals is negligible. We have had this same type of unit in operation over two years with a furnace temperature of 1950°F without a burn out.

The refractories holding these units in place are of multiple length. They have a projecting lug on each side and are held in the wall by a small bolt which enters the wall from the outside. They are individually removable, in case of damage, without disturbing the insulation or unit. They were developed in conjunction with the Electrical Refractories Co., of East Palestine, Ohio.

These kilns are used for the firing of decal, luster, gold, and silver, and are regularly fired to a finish temperature of 1420°F, the temperature being taken in the center of the rear end of the kiln.

The load in these kilns generally constitutes from 450 to 500 pounds of ware, or by count approximately 250 seven-cup porcelain percolators or the equivalent.

The uniformity of temperature throughout this cavity is from front to back a temperature difference of approximately 10°F, and from top to bottom a temperature difference from 20 to 40°F. This is a characteristic of the load, and the amount of baffling stopping circulation.

The cycle of operation for the kiln is to install the car, close the door, close the dampers, put the kiln on low heat for one-half hour, and then on high heat. Open the dampers, during the time the kiln is at a temperature of between 300°F and 400°F to allow burning of sizing, etc., then close the dampers and allow the kiln to reach finish temperature. All this requires a period of from $3^3/_4$ to $4^1/_2$ hours. These kilns are equipped with a control pyrometer, the type used for some time by the metallurgical industry for controlling temperatures. This instrument limits the temperature to which the furnace will go if left unattended.

When the furnace has reached its top heat, it is cut off by the control instrument. The furnace is allowed to cool and the cooling is expedited by opening the dampers which do not in themselves create a draft. When the temperature has dropped to a point below the red heat, and the ware being fired is susceptible to more rapid cooling, it is then possible to elevate the floor platform in this furnace; this raises the sand seal and allows a slight amount of air evenly distributed around the kiln wall to aid in reducing the furnace temperature.

The ware being handled in these furnaces is capable of being removed at 400°F. This is done and the kiln is then reloaded.

In order to make an efficient equitable operating job, one kiln is heated up while the other is cooling down. This takes a practically continuous use of energy and allows from five to six loads per 24 hours from the two kilns, as the ware can then be left standing on the car after it is removed from the kiln at 400°F, until it is cooled down to such a point that it can be handled with convenience. The ware can be placed and removed much more speedily and to better advantage as the car is out in the open and can be gotten at from all sides.

In this kiln when a load has been fired for finished fire decorating, and the car is removed from the furnace, the car can then be delivered to the packing room, inspected, and packed right there, which eliminates considerable handling.

Extra floors are furnished with these kilns to permit of storage both before and after firing.

The same capacity can be purchased in the periodic type kilns for 60% of the cost of the continuous type kiln.

These periodic kilns are of a semiportable type and do not require a foundation. During possible business depression these kilns can be loaded during the day and fired at night, giving the advantage of off-peak power, resulting in lower energy rates. Schedule heat can be changed with any load desired.

An additional advantage in using this type of equipment during periods when the pottery is not at capacity production is that it is possible to run any part of a battery of these kilns with perfect results, while with a continuous type kiln it is necessary to keep a constant load moving through the kiln, which necessitates loading some cars with scrap ware of the required poundage to make up the difference between production and the minimum schedule of the kiln.

The two kilns installed at the Smith Ceramic Studios handle 25% more ware on a floor area of 20 by 20 feet than the gas kilns handled on a floor area of 30 by 40 feet.

Electric installation of any type creates very desirable working conditions as it eliminates excessive room heat and all noises customary with fuel fired equipment.

FALLS ELECTRIC FURNACE CORPORATION
BUFFALO, N. Y.

FIRING CERAMIC WARE WITH GAS[1]

By Henry L. Read

ABSTRACT

The significance of the terms oxidizing and reducing kiln atmospheres to the ceramists and the gas engineer is discussed. The applications, advantages, and comparative costs of various fuels used in the ceramic field are considered.

Introduction

Control The first and most important problem to be overcome in firing practically all classes of ceramic materials is that of control of the atmosphere surrounding the ware. But obviously the expense of installing and operating proper control must be less than the losses caused by its nonuse.

Definition As used in the gas industry and in the present paper, the words "oxidizing" and "reducing" atmospheres are sometimes not entirely accurate. The gas engineer calls a furnace condition "oxidizing" when analysis of the flue products shows an excess of oxygen and little or no carbon monoxide. Conversely a "reducing" condition means to him one in which an excess of carbon monoxide exists with little or no oxygen. The term "neutral" is used when no appreciable amount of either gas is present. The ceramist, however, frequently finds that a small excess of oxygen is insufficient to oxidize and might even permit reduction. Such an anomalous situation might occur with a clay containing considerable carbon which must be burned out before incipient fusion begins. If the pores of the ware are closed by fusion before the carbon is all oxidized out, a black reduced core results. The ceramist would justifiably regard his furnace conditions in such a case as reducing even though no CO is detectable in the gases leaving the combustion chamber. On the other hand, every gas man knows that oxidation may occur under a "reducing" or "neutral" condition. Inspection of the coat of iron oxide on a piece of steel removed from a hot furnace without having been exposed to air or free oxygen will confirm this. Consequently, it is always well to have clearly in mind just what is meant by the terms used.

Contrasting Fuels

Coal With coal, conditions are bound to be more reducing in the furnace gases after charging and more oxidizing when the fires have burned down. If it were not for the air let in over the fire and directly into the bag walls, coal-fired kilns would be alternately wholly reducing and oxidizing and would affect the ware even though muffled or saggered.

[1] Received March 29, 1928.

Oil With oil as fuel, firing conditions are greatly improved over coal firing, since the periodical cleaning and recharging of fires is eliminated. Fluctuating furnace atmospheres still may and do occur unexpectedly, however, due to variations in pressure on oil and air or steam lines, stoppages in oil strainers and needle valves, variations in draft, etc.

Electricity Electricity has in the last few years come forward strongly in the ceramic field as a heating medium. Its high cost per B.t.u. has often been more than offset by its cleanliness and ease of operation and constant oxidizing atmosphere. It has hitherto labored under the disadvantages of lack of a wide range of temperature control and danger of breakdowns. The metallic ribbon resistors used seemed to lack the requisite ruggedness.[2] A far superior type of heating element has been lately developed and keener competition from electricity is expected. But this fuel will probably always be handicapped by high unit cost, partly offset by excellent performance.

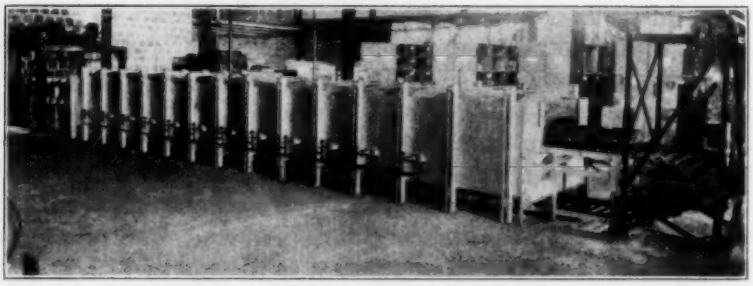

FIG. 1.—Continuous glass leer, gas-fired. Kimball Glass Company.

Gas Gas has been steadily receiving more and more attention in ceramic work. There are certain ceramists of the old school who claim that it may be all right for many operations but that with it heat distribution cannot be obtained evenly in the large downdraft kilns. This statement is not correct. Whether gas is the right fuel economically is something to be determined in each instance.

Muffles Not Needed with Gas

Muffle furnaces are used to insure uniformity of heat, to keep dirt and unburned carbon from the ware, and to eliminate or greatly reduce the amount of flue gases in contact with the work. They serve these purposes, but at the cost of many more heat units than are required by open furnaces, and there is the expense of renewing the muffles.

[2] See *Jour. Amer. Ceram. Soc.*, **9**, 797–804 (1926) for description of electric *vs.* gas furnaces in enameling cast iron.

Gas furnaces are easily built without muffles and give perfectly even temperatures throughout. The question of dirt and unburned carbon in the absence of a muffle is serious even with gas, since dust is often pumped into the burners from the atmosphere. Then too, little pieces of brick or fire clay may drop from the arch upon the ware or may be picked up and deposited by the rapidly circulating gases. Except with an excess of oxygen tiny particles of unburned carbon will spot the ware. A muffle is an excellent protection against such contingencies. Yet it has been demonstrated that by cleaning the air entering the blower with automatic proportioning of the air and gas, and by painting the inside of the furnace with a suitable glaze or vitrifiable wash, muffles are not necessary when gas is used.

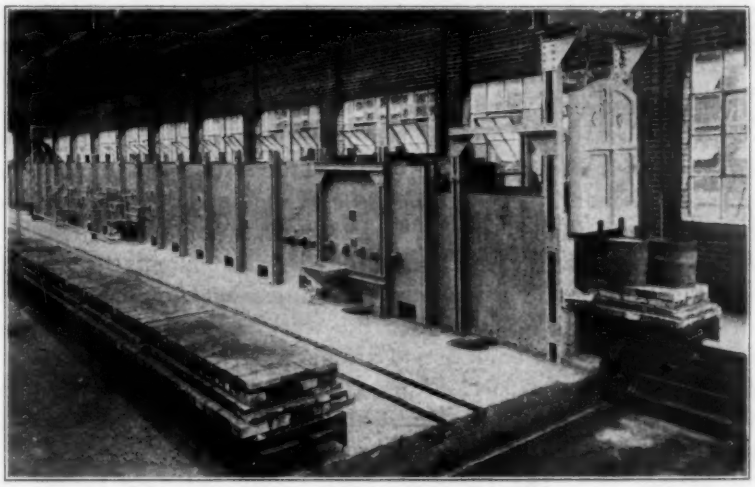

FIG. 2.—Inlet end and preheat zone of gas-fired tunnel kilns used for firing electrical porcelain. Isolantite Company of America.

Ware Loss Reduced

The loss of ware in firing is an item of importance. Kiln losses are expensive and effort to avoid them is justifiable. A more costly fuel would be justified if the percentage of pieces spoiled in the kilns is thereby appreciably reduced. A manufacturer of electrical equipment fired porcelain to cone 11 with coal in a tunnel kiln. When the kiln was altered to burn 525 B.t.u. gas, the number of pieces rejected was so greatly reduced as to justify gas costing about $100.00 per day in place of coal costing approximately $35.00 per day. And in this case the production was increased 5%.

Conditions for Economies with Gas

Tunnel Tunnel kilns cannot be constructed to fire alternately with gas and oil economically. The extra space needed for oil combustion is extremely wasteful of gas. In one case it was estimated that about 15% more gas was being used in a combination oil and gas-tunnel kiln than would have been the case had a proper design for gas alone been used.

Updraft As a general proposition, city gas will not prove to be the cheapest fuel if applied to updraft kilns. These devices are extremely wasteful of fuel. It is possible, however, to use gas economically by changing them from updraft to downdraft, as has been recently shown in a large pottery plant. By this alteration the products of combustion rise along the outer wall to the center of the crown and are then drawn downward. In this way the maximum possible amount of heat is abstracted and utilized.

Enameling Furnaces The continuous automatic enameling furnaces are gas fired indirectly satisfactorily. The steel pieces to be coated are first dipped and then hung on an overhead chain conveyer passing through an oven. The chain, endless, passes around a large sprocket at each end. In one type the cold ingoing work passes parallel and countercurrent to the hot outcoming ware from which it receives considerable heat for drying and preheating. At about the middle of the kiln is the high temperature zone, divided longitudinally into two compartments through which the work passes in opposite directions. The products of combustion are likewise used for preheating the work inside the furnace. In another type, the work travels in one direction countercurrent to the products of combustion, which are taken off at the charging end after passing through a preheater.

Enameling Driers The gases are then conducted to a tunnel drier alongside the furnace. In the drier the work passes in the opposite direction to that in the furnace. At the drier outlet the work may be removed for brushing or edging if desired, or may be left attached to the conveyer which returns via the furnace. With suitable pyrometer control and automatic air-gas proportioning apparatus, either unit is probably as near self-acting as even can be. The only labor required on them is that for dipping and attaching the ware, and for removing it as it emerges. As is to be expected, the thermal efficiency is unusually large and the production rate very high.

Sheet Steel Annealing In conjunction with enameling sheet steel, most plants require equipment for annealing or acid scaling or both. Such work is probably most satisfactorily done by gas in continuous automatic furnaces. The temperature, 1200 to 1400°, is a little too low for oil to be entirely satisfactory, mainly be-

cause of the danger of a deposit of carbon occurring on the steel. This deposit is difficult to remove and is apt to pack in the dies. In that case, the stampings do not come out true and excessive wear takes place on both dies and presses. If the furnace atmosphere with oil as fuel is made sufficiently oxidizing to avoid free carbon, the resulting scaling of the ware is excessive. The easy control of the atmosphere and elimination of floating carbon with gas as fuel make the latter preferred in most cases.

Glass Factories The greatest field for gas in ceramic work probably lies in glass factories. Heat is needed for practically every operation, and gas has steadily shown itself to be unequaled for the purpose. All forms of gas appliances, from little needle bunsen burners consuming a few cubic feet per hour to huge melting tanks requiring hundreds of thousands of cubic feet, are in successful and constant use. Continuous annealing leers also are gas fired economically and with low losses.

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THE PORES IN BRICK[1]

By G. J. Easter

ABSTRACT

The mathematical theory underlying the reduction of heat losses through bricks by means of finer subdivision of the pores is briefly reviewed. For comparison of the size and number of pores in different bodies the resistance to the flow of air through materials is measured and the pores arbitrarily considered to be replaced by an equivalent volume of parallel cylindrical capillaries extending through the brick and of such size and number as to offer equivalent resistance to air flow. The dimensions of these capillaries are then computed. The method is applicable only to bodies having open pores.

Introduction

The question "how large are holes in brick" can be answered only indirectly and academically, but is far from being of purely academic interest. It is of importance not only for brick but also in the case of many other ceramic bodies where the answer is very apt to be closely related to important factors in the practical performance of the material. The present investigation, however, is confined to brick, where the matter of pore size is of greatest interest in connection with the thermal conductivity.

Effects of Pore Size on Thermal Conductivity

While per cent porosity has some relation to insulation value, two bricks of identical porosity and material need not have equal conductivities. The reason for this is considered here in an elementary way.[2]

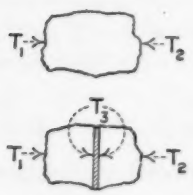

FIG. 1.

Transmission of heat through a porous refractory occurs through three agencies, (1) radiation across the pores, (2) conductivity through the solid material and through air in the pores, and (3) convection within the pores.

The latter two are at a rate proportional to the difference between the first powers of the temperatures at two adjacent points. The first is proportional to the difference between the fourth powers of the absolute temperatures $T_1^4 - T_2^4$ and becomes an overwhelming factor where $T_1 - T_2$ is large.

Factoring the expression algebraically is interesting, however, as it gives the formula

$$(T_1^3 + T_1T_2^2 + T_1^2T_2 + T_2^3)(T_1 - T_2)$$

When T_1 and T_2 are about equal this reduces to

$$4T_1^3(T_1 - T_2).$$

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.) Received February 27, 1928.

[2] For a more extensive treatment see F. H. Schofield, article in Glazebrook's Dictionary of Applied Physics, Vol. 1, pp. 431 and 471.

That is, where the temperature drop is small, the radiation rate while high may be considered as varying with the difference between the first powers rather than the fourth powers of the temperatures involved.

This is approximately the condition which prevails across a pore of an insulating refractory. The distance and the temperature drop are small, therefore across the pore the heat transfer is proportional to $T_1 - T_2$.

The pore is shown diagrammatically in Fig. 1 and the radiation across it may be given as $T_1 - T_2$. If, however, an intermediate partition is inserted midway between the pore walls, it must assume some temperature, T_3, between T_1 and T_2. If for the sake of argument we assume

$$T_3 = \frac{T_1 + T_2}{2}$$

the radiation which is now $T_1 - T_3$ is decreased to

$$\frac{T_1 - T_2}{2}$$

or one-half its former value. Further subdivision of the pore similarly reduces the heat flow. Schofield estimates that with a temperature drop from 25°C to 10°C across a 3-inch space, the presence of only nineteen intervening partitions will cut the heat transfer by radiation to an amount equal to the transfer by pure conduction through still air.

A similar argument shows the advantage of subdivision in reducing heat flow by convection, though here the urgency is not quite so great as that for reducing radiation at high temperatures.

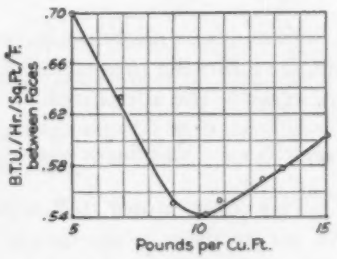

FIG. 2.—Conductivity vs. density slag-wool insulation (Petavel).

It is important that the fact be recognized at this point that there is a limit to the efficacy of subdivision. All solids are better conductors than air and as the number of partitions increases it is obvious that the amount of heat flowing by conduction through the solid must increase. Finally this increase outweighs the decrease in heat transfer across the pores and the heat transfer through the body as a whole again increases.

The exact point at which this minimum heat transfer occurs is a function of body structure and the thermal conductivity of the solid itself but is beyond mathematical prediction. Its real existence has been demonstrated, however, by Petavel,[3] who packed slag wool at different densities and measured the thermal conductivity. (See Fig. 2.)

[3] Glazebrook "Dictionary of Applied Physics" Vol. 1, p. 431.

Measurement of Permeability to Air

This theory may be interesting but the problem here is to evaluate pore size and to compare the pores in one body with those in another. To do this a permeameter[4] of the type shown in Fig. 3 has been utilized to measure the resistance of the brick to the flow of air through it.

It has been found more satisfactory to make measurements under slightly higher pressures than those recommended,[4] as in this way the time-lag before the flow is stabilized seems to be largely eliminated. The measurements recorded below were made accordingly with a pressure drop amounting to two inches of water across the specimens which were 9-inch straights, the air-flow being through the broad face of the bricks.

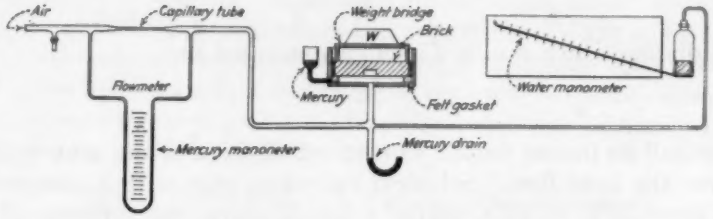

FIG. 3.—Diagram of permeability meter.

Results on all pieces have been reduced to a comparable basis by use of the following formula which was empirically verified within the limits of error of the apparatus.

$$\text{Unit flow} = \frac{\text{Total flow} \times \text{thickness of specimen}}{\text{Area of face} \times \text{pressure drop} \times \text{time in minutes}}$$

The unit flows following are expressed in cubic centimeters of air at room temperature flowing per minute through a centimeter cube of material with a pressure drop of one centimeter of water between its faces. They represent a number of standard refractories available on the market, though it is obvious that they do not represent all of the brick of each general class as wide variations may occur in each group.

TABLE I

(Flow (F) per unit cube with unit pressure drop, cc. per minute)

Brick	Unit flow	Air porosity %
Pennsylvania fire clay	8.12	21.4
Georgia kaolin	5.30	33.0
Silicon carbide (bonded)	0.36	21.4
Porous clay insulator	19.70	63.9
Calcined diatomaceous earth	3.92	76.0

[4] For description see A. E. R. Westman and W. H. Pfeiffer, *Jour. Amer. Ceram. Soc.*, 9 [9], 626–32 (1926).

Permeability and Pore Size

In order now to relate these figures to pore size some assumption must be made as to pore shape and distribution. In reality the pores in a ceramic body are very irregular in both direction and diameter. Slichter[5] has worked out the pore size and shape on the assumption that the body is composed of small spheres all of equal diameter.

The expression for pore size which he derives is complicated, however, and as such a body never exists among refractory brick, the simpler assumption has been made that the pores are replaced by an equal volume of parallel cylindrical capillaries having equal diameters and running from one face of the specimen to the opposite one and perpendicular to the faces (Fig. 4). This is far from the actual arrangement but at least it permits comparison of figures on different bodies with some degree of fairness.

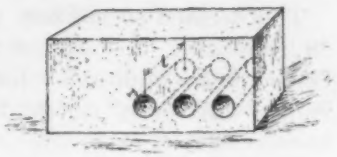

FIG. 4.

Through each such tube (by Poiseuille's law) the air flow

$$V=\frac{\pi r^4 P}{8nt}$$

Where

V = the flow in cc. per second
r = the radius of the capillary in cm.
P = the pressure difference between ends of the tube expressed in dynes per cm².
t = the thickness of the specimen in cm.
n = the coefficient of viscosity for the fluid flowing (being 0.00018 for air at 20°C)

If for each cm.² of the face of the test specimen it is assumed that there are N tubes, the total flow, F, through the brick per cm.² will be

$$F=NV=\frac{N\pi r^4 P}{8nt}$$

and the volume of the pores per cm.² of face will be

$$N\pi r^2 t=\frac{\%\text{ porosity}\times t}{100}$$

These equations solved for r and N result as follows for the case where the fluid is air and F is expressed as in Table I.

$$r=0.00156\sqrt{\frac{F}{\%\text{ por.}}} \qquad N=1300\frac{(\%\text{ por.})^2}{F}$$

As a check on calculations it may be noted that $100\pi r^2 N=\%$ porosity.

Using these formulas and the data of Table I the following data for Table II are obtained.

[5] U. S. Geol. Surv., 19th Annual Report, Part 2, p. 301.

TABLE II

Brick	r = radius of equiv. cyl. cm.	N = no. of cyl. per cm.^{3}
Pennsylvania fire clay	.00096	73,400
Georgia kaolin	.00062	267,000
SiC (bonded)	.00020	1,650,000
Porous clay	.00086	269,000
Calcined diatomaceous earth	.00035	1,920,000

It is impossible to visualize data of this sort but the values for various materials may be compared with one another with interesting results. Is it true for instance, that silicon carbide and diatomaceous earth refractories (the best and poorest conductors of heat) have pores of the same order of magnitude both in size and number?

This seemed so unlikely that the faces of the former were ground off, removing the surface glaze, and the measurements repeated. Under these conditions r for SiC becomes .00030 cm. and N 753,000, values sufficiently different from the diatomaceous earth to seem more plausible.

This change, however, points very clearly to the limitation of this method of analysis. It can be fairly applied only where the pores are relatively completely open and not where they are sealed or have "dead ends."

CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.

NOTE ON THE VAPOR ABSORPTION OF A FIRED EARTHENWARE BODY[1]

By C. L. Deeds

ABSTRACT

Specimens of an earthenware body fired at three temperatures were placed over a 10% sulphuric acid solution for 36 days and the gain in weight determined. Up to a certain limit of porosity the absorption is proportional to the porosity, but the body with the highest absorption, 20.25% took up a relatively higher amount of water. With an absorption of 8.81%, the maximum amount of water vapor taken up was 0.13%. With 10.8% absorption the water vapor taken up was 0.16 and with 20.25% absorption it reached 0.54%.

Introduction

In the course of a study of porous body structures it was thought desirable to determine the absorption of aqueous vapor by an earthenware body in regular use when subjected to a practically constant vapor tension. It should be expected that more porous substances, having a larger pore area, should absorb a larger amount of moisture, proportional to the surface exposed. According to the work of Patrick, Preston, and Owen,[2] it would appear that the absorption constants should depend chiefly on the structure of the absorbing substance. As to the mechanism of the absorbing action Patrick considers it to be a condensation in the capillaries independent of the chemical nature of the absorbent.

The Test

In order to show the difference between the absorption of the same body with different porosities, experimentally, small disks weighing about 10 grams, made from the regular body, were used. These were fired under three conditions: (1) in the first ring of an updraft kiln, (2) at the well hole of the same kiln, and (3) in a tunnel glost kiln. Under the first conditions the absorption was found to be 8.81%, under the second, 10.8%, and under the third, 20.25%. The disks were weighed immediately after ignition and cooled in a dessicator. They were then placed upon a grid above a 10% solution of sulphuric acid, contained in a tightly stoppered glass jar. The temperature was that of the laboratory and subject to variations between 15 and 20°C. The disks were thus kept for 36 days and weighed quickly on the chemical balance at intervals at first of two days and later of seven days.

Results

The results showing the relation between time and the amount of water absorption, are plotted in Fig. 1. The curves for the two lower

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, February, 1928. (White Wares Division.) Received June, 1928.

[2] *J. Phys. Chem.*, **29**, 419, (1925).

absorptions are in satisfactory agreement. The weights of absorbed water are proportional to the absorption values, which are equivalent to the porosities. In the case of the 8.81% absorption the weight of water taken up was 0.0136% per 1% absorption, and for the 10.8% absorption the weight increase was 0.0139%, on the same basis. With reference to the 20.25% absorption specimen it is apparent that an equilibrium was not established since the curve fluctuates widely due probably, in part, to a more pronounced loss during the weighing operation. Taking the 12-day value which seems to be fairly consistent, the weight increase per 1% absorption was 0.0217% which is considerably higher than the rate for the harder fired body. The total increase in weight for the 8.81% absorption was 0.13%, for the 10.8% absorption, 0.16%, and for the 20.25 absorption, 0.54%, these being the maximum values.

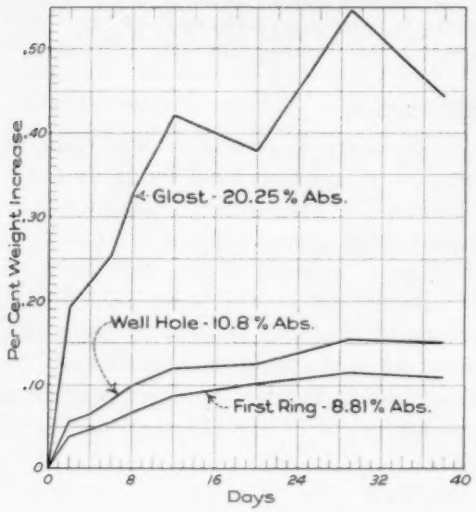

FIG. 1.—Curve showing the relation between time and the gain of the earthenware disks.

This simple experiment had for its object the determination of the amount of water vapor that might be absorbed during the usual time of bisque ware storage and to show the differences in this respect between the harder and easier ware. Within the ordinary range of absorptions it seems that the amount of moisture taken up is proportional to the porosity. Very soft bisque shows not only a higher rate of vapor absorption but also more variation and perhaps a more unstable condition of absorption. This might be due to the larger pores which exist in such underfired bisque. The hygroscopic character of the anhydrous clay substance is thus very evident. As to the glazed ware it would seem that it likewise should absorb moisture through the pin holes though at a much slower rate.

It would be desirable to know the vapor absorption of the various clays alone, fired to several temperatures. In further work it might be advisable to use a salt solution for producing a condition of constant humidity, such as a saturated solution of $BaCl_2 2H_2O$, or one of oxalic acid.

Acknowledgment This experiment was suggested by A. V. Bleininger.

THE HOMER LAUGHLIN CHINA COMPANY
NEWELL, W. VA.

TERTIARY CLAYS OF SOUTHERN CALIFORNIA[1]

By Robert Linton

ABSTRACT

A discussion is given of the occurrence, geology, use, mining, and physical properties of some California pottery clays. The term "pottery clay" is used to designate all clays employed in manufacturing clay products other than common red building brick and articles of similar grade. Chemical analyses are given for the principal clays.

Introduction

California pottery clays are almost entirely confined to two districts, about three hundred and fifty miles distant from each other. One of these is in Amador and Placer Counties, extending from Ione on the south to Lincoln on the north. The other is in Riverside, Orange, and San Diego Counties, extending from Corona and Santa Ana southward to Del Mar. The clays occur in scattered deposits, varying greatly in character, purity, area, and thickness.

The term "pottery clay" is used to designate all clays employed in manufacturing clay products other than common red building brick and articles of similar grade. Clay for the latter is designated "brick clay." There are very large and numerous deposits of brick clays in California, occurring as late Tertiary and Quaternary fluviatile beds. These are not included in this discussion. Good pottery clays are relatively scarce, although sufficient to supply raw materials for the California industry.

The present paper is largely a résumé of studies in the field and laboratories of clays used by the Pacific Clay Products Company, Los Angeles, Calif. That company manufactures in its several plants a wide variety of ware, including vitrified salt-glazed sewer pipe and electrical conduit, stiff-mud and dry-press face brick, stiff-mud and hand-molded clay fire brick, terra cotta flue lining, drain tile, roofing tile, and glazed and unglazed earthenware. Over twenty different clays are used in the operations, mostly from the company's own mines, and they cover in quite a comprehensive way the various types of pottery clay found in southern California.

General Geology

The general geology of the areas under discussion has been studied by Lindgren, Vaughan, Lawson, Dickerson, Turner, Merrill, and others.[2] The record shows that through the Paleozoic era there was quiet, persistent building of the continent from disintegration of the granites and granodiorites which had invaded the region in pre-Cambrian time. Decomposition of these rocks furnished the materials

[1] Received February 15, 1928.

[2] See *Bibliography*, p. 781.

which the advancing and receding ocean laid down in shales, sandstones, and conglomerates, while at the same time reef-building corals and other organisms were forming the thick beds which are now the limestones and organic siliceous shales. In the Mesozoic era there were upheavals which raised and compressed these strata, producing quartzites and schists, and accompanied by abundant intrusions of igneous rocks, especially granite and granodiorite. These movements had much to do with the formation of the Sierra Nevada and Sierra Madre mountain ranges in whose granites the California clays have their origin. The Sierra Madre range, which lies to the east of the southern clay belt, begins with the San Gabriel Mountains in Los Angeles County and extends southward through the San Bernardino and San Jacinto Mountains into Mexico. These mountains are not the result of any single uplift, but of crustal movements at various times in the Mesozoic and early Tertiary.

FIG. 1.—Shale deposit, San Diego County.

The Miocene and Pliocene are the epochs in which most of the California pottery clays were laid down. During the whole or at least the greater part of this time, it appears that the Great Valley of California was a gulf connected with the Pacific Ocean by one or more arms through what are now the Coast Ranges; the Gulf of California extended northward to what is now the San Gorgonio Pass of the San Bernardino Mountains; and the western slope of the Sierra Madre was building up a series of marine terraces which fresh water streams transformed into a series of deltas.

During Tertiary time successive uplifts due to stresses and faulting formed the San Bernardino Mountains which isolated an arm of the Gulf so as to divert its drainage to the north and west. Westward flowing streams worked profound erosion, cutting out deep canyons, transporting the resulting débris and depositing it along the sides of the ranges.

While there appear to have been several stages of granitic intrusion, none of importance occurred after the Jurassic. There were lavas and tuffs resulting from volcanic activity, especially toward the end of the Tertiary. Some of these overlie the clay deposits.

Clay-forming Rocks

The igneous rocks which constitute the principal masses of the Sierra Nevada and Sierra Madre Mountains have, as stated, provided the materials for the inorganic sediments of California. The various periods of intrusion have yielded quite a variety of rocks, ranging from acid to basic, but the granites and granodiorites which formed the original core and many subsequent intrusions predominate in the mountain structure.

The breaking down and hydration of these rocks yielded sand, clay, iron hydroxides, and small quantities of other substances. The alkalis went into solution and were carried away. The residual materials rarely became separated from each other, for the coastal plain was then, as now, narrow, and the streams which carried the débris were short and swift. Consequently there was little separation of the various constituents and practically the whole enormous volume of Tertiary sediments is composed of mixtures of all these constituents and of little or no economic value. Occasionally, but rarely, currents were favorable to separation of quartz and clay substance, and under such conditions beds of pottery clays of commercial importance were formed.

In F. J. H. Merrill's excellent monographs[2] the granites are described. Most of them appear to contain orthoclase and plagioclase (orthoclase predominating) with quartz, hornblende, and biotite. Magnetite occurs occasionally, and orthoclase is sometimes partly kaolinized. Muscovite and augite are rarely observed.

Samples of granite taken from outcroppings in the vicinity of clay mines in Orange and Riverside Counties are of similar character, *viz:* orthoclase, quartz, and hornblende predominating, with biotite and plagioclase of less frequent occurrence. Analyses of these granites are as follows:

	Riverside County	Orange County
Ignition loss	.02	.78
SiO_2	73.40	72.50
Al_2O_3	14.79	14.68
Fe_2O_3	3.33	1.88
CaO	1.51	1.56
MgO	0.23	0.48
Alkalis	6.48	7.00

It seems quite clear that the pottery clays of southern California are derived from decomposition of the acid granites in which orthoclase predominates. This feldspar weathers easily, the alumina silicate altering to hydrosilicate, and the alkalis leaching out. The mixture of clay substance with quartz and other insolubles is readily separated in water under favorable flow and current conditions.

As an illustration of the way in which these clays may form, the transition of the Riverside County granite through a siliceous clay to a high-grade plastic clay is given below:

	Granite	Equivalent analysis	Equivalent analysis
Ignition loss	.02+ 8.38= 8.40	12.86− 2.91= 9.95	15.60
SiO_2	73.40−33.86=39.54	60.56−30.98=29.58	46.36
Al_2O_3	14.79 =14.79	22.65 =22.65	35.49
Fe_2O_3	3.33− 1.59= 1.74	2.66− 1.35= 1.31	2.05
CaO	1.57− 1.21= 0.36	0.55− 0.35= .20	.32
MgO	.23− .17= 0.06	0.09− 0.08= .01	.01
Alkalis	6.48− 5.96= 0.52	0.80− 0.66= .14	.23

The two columns headed "Equivalent Analysis" are the analyses of actual commercial clays. In the calculations the alumina is assumed to be unchanged.

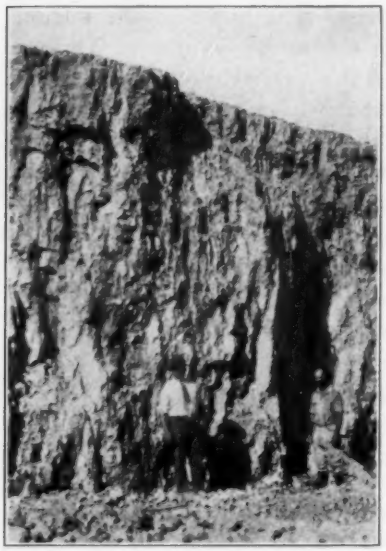

FIG. 2.—Kelly Mine, San Diego County

In southern California the later flows, principally andesitic lavas and tuffs, do not appear to have contributed to the formation of commercial clays. In connection with the Amador and Placer County clays it has been suggested that some of the white clays of the Ione formation may be derived from rhyolite tuffs, which in that case must have been laid down in the late Eocene. There does not seem to be any evidence pointing to a similar origin for southern California clays.

The age of the deposits has been quite definitely determined as Tertiary through correlation of the clay-bearing areas with the geological mapping of the region. No comprehensive study of the geological history has been made in the field by the writer, but occasional fossils which have been found in connection with mining and prospecting work have all been of that period. While most of the clays were laid down in the Miocene and Pliocene time, there are a few commercial deposits as early as Eocene and as late as Pleistocene.

Clay Deposits

The vast inland bays which in late Tertiary time covered the Great Valley of California and the region south of San Gorgonio Pass were separated from the ocean by the coast ranges and were, therefore, favor-

able to sedimentation. Prior to that time, the older sediments and metamorphic rocks forced up by the granites had been largely eroded, so that in Miocene and Pliocene time decay of the granites themselves furnished the materials for sedimentary deposition. Streams cut deep canyons in the mountain masses and washed the débris down into the broader shoal basins below. Here the heavier sands settled first, and the lighter and finer aluminous constituents either settled above them or were carried on to quieter bays where eddying currents effected their deposition.

The clay beds are characteristically irregular in area and thickness. Red-mottled clays, more or less mingled with sand, constitute the largest and most continuous. These clays, undoubtedly laid down in arms of the ocean, form the lowest member of the commercial clays. The finer pottery clays, comprising the light firing plastic clays and the higher refractory clays, lie conformably above them, where the two are associated, and the beds are much smaller. Some of these are probably fresh-water deposits. The best clays frequently lie in coal measures, overlying thin seams of lignite.

FIG. 3.—Elsinore Mine. Red-mottled clay.

A few deposits lie in the area between the hills and the coast. These would appear to be largely fresh-water clays. Lawson[2] considers the San Diego Mesa to be genetically a composite Pliocene delta. The shore lands north as far as Oceanside are of much the same character. It is in this area that the clays are found, but in much smalier deposits than those occurring in the inland valleys.

Clays which have been hardened into true shales are rare in southern California. One of these exceptional deposits is shown in Fig. 1. The characteristic type of deposit is massive and without stratification within the clay bed itself, as shown in Fig. 2.

The Clays

Southern California Tertiary clays may be classified as follows: (*a*) red-mottled clays, (*b*) light firing plastic clays, (*c*) dark firing plastic clays, (*d*) siliceous refractory clays, (*e*) bauxitic refractory clays, and (*f*) shales.

This does not include the large deposits of red clays used extensively for manufacture of common red brick, which nearly all belong to the Quaternary.

Red-mottled Clays These are the most extensive and widely distributed of all the Tertiary clays. They are made up of a mass of mingled materials resulting from erosion of the Sierra Madre, and carried by swiftly running rivers down to the sea, where without much purification, they were laid down beyond the shore line. They are variable in quality, plasticity, strength, and working properties, and must ordinarily be used in combination with other clays. Characteristic analyses are as follows:

	(1)	(2)	(18)
Ignition loss	9.98	8.73	12.52
SiO_2	56.58	63.86	53.55
Al_2O_3	24.16	20.93	25.24
Fe_2O_3	8.27	4.12	6.63
TiO_2	0.65	0.59	0.43
CaO	0.10	0.24	0.27
MgO	0.16	1.09	Trace
Alkalis	0.59	0.83	1.08
	100.49	99.39	99.72
Drying shrinkage (%)	7	3	6
Firing shrinkage cone 9 (%)	8	3	6
Fusion temperature (cone) (%)	16	27	20

Light Firing Plastic Clays Good clays of this type are of infrequent occurrence and limited extent. The largest deposits are found in the mines at Alberhill near the head of the Temescal Valley. There are indications that some of the purer clays may have resulted from removal and secondary deposition of the clays originally laid down, with further washing out of impurities. Some of the clays are of unusually fine texture, equalling the best English ball clays. They are usually too plastic to work alone and are used to provide the bonding material for less plastic clays. Refractory clays used for bonding fire brick are included in this classification. Characteristic analyses are as follows:

	(3)	(4)	(5)	(6)	(7)
Ignition loss	13.60	9.00	15.60	8.34	6.97
SiO_2	52.30	65.14	46.36	63.04	72.56
Al_2O_3	29.37	23.30	34.52	24.82	18.25
Fe_2O_3	2.72	1.16	2.05	1.64	0.63
TiO_2	0.63	0.86	0.97	0.74	0.48
CaO	1.18	0.60	.32	0.44	0.54
MgO	0.45	0.13	.01	0.35	0.22
Alkalis	0.37	0.15	.23	0.68	0.30
	100.62	100.34	100.06	100.05	99.95
Drying shrinkage (%)	8	5	5	6	8
Firing " at cone 9 (%)	15	10	15	12	11
Fusion temperature (cone) (%)	30	30	33	30	28

Dark Firing Plastic Clays These are not much more plentiful than the clays in the preceding group. They differ in composition from them chiefly in the amount of iron contained. Where clays have been washed sufficiently to separate a large proportion of plastic material from the heavier impurities, the iron usually has remained with the latter but there are occasional beds in which the iron is very intimately associated with the alumina, and these are excellent for ware where dark colors are desired. These clays fuse at lower temperatures than the light firing plastic clays. Characteristic analyses are as follows:

	(19)	(20)	(8)	(9)
Ignition loss	9.12	11.02	6.26	10.24
SiO_2	53.34	52.12	65.98	56.40
Al_2O_3	23.41	25.10	18.89	24.61
Fe_2O_3	11.65	8.66	4.95	5.40
TiO_2	0.94	0.56	0.60	0.83
CaO	0.46	0.34	1.06	0.96
MgO	0.06	1.48	0.61	0.82
Alkalis	0.09	0.93	2.20	0.81
	99.07	100.21	100.55	100.07
Drying shrinkage (%)	6	10	2	8
Firing " at cone 9 (%)	11	16	8	12
Fusion temperature (cone) (%)	19	8	29	28

Siliceous Refractory Clays There are two types of siliceous refractory clays: (1) clays composed of a lean mixture of refractory clay substance (hydrated alumina) and sand, and (2) clays in which the silica is largely combined, resembling in structure and behavior eastern flint clays. The latter are very scarce in California, the former somewhat more abundant. The clays are usually low in plasticity and bonding strength and require in practice the addition of some more plastic bonding material. Characteristic analyses are as follows:

	(10)	(11)	(12)	(15)
Ignition loss	10.62	10.68	12.86	8.42
SiO_2	57.38	58.76	60.56	65.94
Al_2O_3	26.89	25.18	22.19	21.89
Fe_2O_3	2.06	4.34	2.66	1.41
TiO_2	0.73	0.56	0.46	0.76
CaO	1.90	0.50	0.55	0.10
MgO	0.11	0.17	0.09	0.26
Alkalis	0.13	0.26	0.80	0.21
	99.82	100.45	100.17	98.99
Drying shrinkage (%)	3	2	8	5
Firing " at cone 9 (%)	6	4	15	6
Fusion temperature (cone) (%)	30	29	28	32

Bauxitic Refractory Clays These clays are locally termed "bone." They are of low plasticity, high alumina content, fine texture, and ordinarily of a characteristic oölitic structure.

They show high fusion points when the iron content is low, but most bone clays carry too much iron to make them desirable for manufacture of refractories. Characteristic analyses are as follows:

	(13)	(16)	(17)	(14)
Ignition loss	15.85	14.32	16.34	14.40
SiO_2	44.31	44.38	43.20	38.60
Al_2O_3	33.33	38.54	29.55	38.24
Fe_2O_3	4.56	2.22	9.67	6.45
TiO_2	0.87	0.82	0.90	1.16
CaO	0.22	0.58	0.56	0.01
MgO	0.14	0.19	0.08	0.48
Alkalis	0.27	0.13	0.20	0.20
	99.55	101.18	100.50	99.54
Drying shrinkage (%)	4	3		6
Firing " at cone 9 (%)	9	13		12
Fusion temperature (cone) (%)	33	34	30	30

Shales These are of rare occurrence among California Tertiary clays, most so-called shales being thinly bedded deposits of argillaceous sandstone. The deposit shown in Fig. 1 is a true shale and analyses of the two varieties of material mined from it are as follows:

	(21)	(22)
Ignition loss	4.72	5.65
SiO_2	67.40	64.50
Al_2O_3	21.40	21.38
Fe_2O_3	2.16	3.42
TiO_2	0.59	0.75
CaO	0.02	0.26
MgO	0.19	0.07
Alkalis	2.58	2.91
	99.06	98.94
Drying shrinkage (%)		1
Firing " at cone 9 (%)	6	5
Fusion temperature (cone) (%)	16	13

Of the above clays, Nos. 1 to 14 are from Riverside County, Nos. 15 to 17 from Orange County and Nos. 18 to 22 from San Diego County.

Stratification of the clays is irregular. Commercial deposits generally comprise two or more distinct strata of clays varying materially in composition and properties, and in these strata there may be found lenses of still others. The purity of some clays varies widely in the same stratum, so that while some parts of a bed may be of excellent commercial grade, other parts may contain so much silica or iron as to render the clay worthless. Ordinarily central portions of clay areas contain the best grade, impurities increasing with distance from it, but this characteristic is not without its exceptions.

Mining

It will be evident from the above that great care must be exercised in mining these clays and separating them into various kinds and grades

suitable for use in the ceramic industry. Only a few pottery clay beds in southern California are thick enough and of sufficiently uniform quality to justify mechanical equipment for mining. Usually the clays lie near the surface and are worked in open pits by ordinary pick and shovel methods. Where power shovels are used, they are caterpillar mounted machines of a half cubic yard capacity or less. These are best suited to operations on account of their flexibility and precision. Larger shovels are more cumbersome to move and more difficult to operate so as to keep the different clays from becoming mixed. In some mines stripping the overburden is done by a power shovel and the clays mined by hand labor.

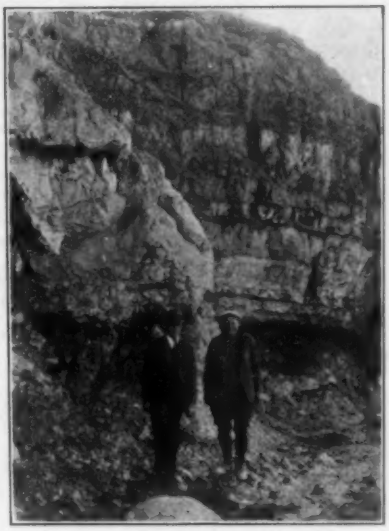

FIG. 4.—Douglass Mine. Light firing plastic clays in coal measures formation.

Underground mining is by the room and pillar method, the rooms being usually about 8 to 12 feet wide, with pillars varying from 10 to 12 feet. Under the most favorable conditions 75% of the clay is recovered, but ordinarily recovery is not much over 50%. This is mined in strata, which include only better varieties used for the finer classes of products whose value justifies use of expensive clays. The lower grade clays which would be recovered in open pit mining are lost. Underground mining is of course only practiced when the depth of overburden makes cost of open pit operation prohibitive.

Utilization

In contrast to many other centers of clay products manufacture, especially in the heavy clay products lines, no one of the pottery clays contains within itself the chemical and physical structure which can be molded into shape and converted by firing into clay ware of good commercial value. In all cases, it is necessary to blend two or more clays to produce these wares.

The clay beds generally yield two or more varieties of clay; each commercial ceramic body requires two or more clays to produce it. The clay products industry as a whole requires a considerable number of clays differing in properties; the southern California clay deposits as a whole yield clays which, when properly blended, meet these requirements. The problem is one of correlation but it is rather complex. It has

required many years of experience to develop the skill in clay blending possessed by southern California clay workers, skill which is so largely responsible for the recognized excellence of the products manufactured from these clays.

It may be of interest to add analyses of a few commercial bodies made from mixtures of clays described in this paper:

	Pressed face brick	Siliceous fire brick	Aluminous fire brick	Sewer pipe	Gray stoneware
Ignition loss	0.16	0.05	.11	.16	.28
SiO_2	62.36	71.90	51.51	62.44	68.34
Al_2O_3	33.45	25.07	45.92	23.99	26.15
Fe_2O_3	2.01	1.62	1.53	7.85	2.35
CaO	1.32	.49	Trace	2.02	1.08
MgO	.44	.17	Trace	1.20	0.55
Alkalis	.63	.37	0.20	2.87	1.69
	100.37	99.67	99.27	100.53	100.44

If these analyses are compared with the analyses of some of the clays given in this paper, it will be found that on recasting the latter to a dehydrated basis, some of them are quite similar to the composition of the finished ware. For example:

	No. 6 (p. 776)	No. 15 (p. 777)
SiO_2	68.7	72.1
Al_2O_3	27.0	24.0
Fe_2O_3	2.6	2.3
CaO	0.5	0.1
MgO	0.4	0.3
Alkalis	0.7	0.2
	99.9	99.0

Number 6 approaches closely the analysis of the stoneware body and No. 15 that of the siliceous fire brick given above. The clays cannot, however, be used without blending to make stoneware and fire brick. They lack some property essential to molding the article or firing it.

Little is known about the mineralogical changes which take place in the maturing of a clay body under heat. It has been shown that sillimanite and mullite crystals develop in firing aluminous refractories at high temperatures. Tridymite and cristobalite develop in highly siliceous bodies. The characteristic phenomenon on firing all clay bodies is the formation of glass or slag by combination of certain bases with silica. These silicate mixtures, possessing lower eutectics than the constituents of the clays which compose them, soften and flow around the more infusible particles, forming upon cooling the dense, stable, and permanent bodies characteristic of ceramic wares.

It would be an alluring field for scientific research to follow this vitrification process in its development, determining the composition of the glasses and slags formed, the limits of crystallization and the

effect of physical structure on the characteristics of the body. Ceramic processes complete a cycle begun ages ago when heated magmas, forced upward through the earth's crust, cooled to massive rocks. Out of remnants of those rocks' decay, purified of their disintegrating ingredients, are molded our ceramic ware, in the firing of which there is doubtless duplicated in part the mineralogical development of the plutonic rocks which were their ancestors.

Acknowledgment The writer desires to express his appreciation of the assistance of William McClintock, assistant general manager of this company, who is in charge of clay mining and prospecting, and of F. A. McCann, ceramic engineer, in connection with the preparation of this paper.

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PACIFIC CLAY PRODUCTS COMPANY
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LOS ANGELES, CALIF.

CLAYS AND CLAY DEVELOPMENT OF LOUISIANA[1]

By J. W. Whittemore

ABSTRACT

The history of the surface geology of Louisiana is given. The various geological formations of the state which contain clay that might be used to manufacture ceramic products are described. The properties of the clays that are of commercial value are considered. The cheap labor, cheap gas, good markets, and good transportation facilities of the state afford excellent possibilities for ceramic manufacturers.

Introduction

The state of Louisiana has numerous clay and shale formations suitable for the manufacture of ceramic products. It also has the world's largest gas field.

Louisiana is covered with the younger geological formations, and parts of the state are covered with heavy mantles of alluvium or recent material carried down by the rivers and deposited in times of overflow. This material is practically valueless for fired clay products, although it does make rich agricultural lands.

Geological History

The history of the surface geology of Louisiana starts with the late Cretaceous and continues through the Midway, Wilcox, and lower Claiborne of the Eocene; the Pascagoula of the Miocene; the Citronelle of the Pliocene; the Pleistocene and the Recent or alluvial material.

The Pleistocene, of which there are considerable exposures is at the present the source of clay for five brick yards. It is most suited for a dry-pressed ware because of high drying shrinkage.

The Citronelle, a formation that carries considerable sands and gravels is of little value.

The Pascagoula, a gray or greenish clay outcrops along a narrow belt just below the Mississippi state line, and in another narrow belt through the lower west central part of the state. Although these clays have a fairly high shrinkage they are suitable for common brick and will make a good grade of ware.

The Hattiesburg, a gray and greenish clay outcrops bordering the Pascagoula in a narrow belt on the western side of the state and the tests are similar to the Pascagoula.

The Catahoula, Vicksburg, and Fayette all have some objectionable material in them, either excessive sand or calcareous materials.

The other formations up to the Wilcox are a series of continental and marine beds made up of strata of clay, sand, and calcareous material. There are, however, several deposits in these formations

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Terra Cotta Division.)

which are of value for the manufacture of brick and tile. They outcrop over a considerable area through the central and north central parts of the state.

The Wilcox which is found in the northwest section is also suitable for the manufacture of the same classes of ware.

The Midway Eocene is the best formation in the state. It outcrops in only a few sections of the northern and central portions of the state. This clay varies from yellow through gray to grayish black and has a depth of approximately 400 feet. Up to a short time ago, there was only one point at which it was considered that the Midway outcropped. This was in the Bellevue Oil Field. As the work of drilling for oil has been carried on, it has been found that this Midway formation outcrops around many of the salt domes. The salt domes in being thrust toward the surface have carried upward the material overlying, and due to erosion the Midway has been subsequently exposed. This clay with a low shrinkage both in drying and in firing is the material being used in many of the plants making a high grade ware such as sewer pipe, paving brick, etc., in Arkansas, Mississippi, Alabama, and Tennessee.

Extensive deposits of white and buff firing clays have been found in the state and with the cheap fuel and labor which abound in Louisiana, the easy transportation that the navigable rivers afford, and the good markets in Louisiana and along the gulf, this state affords a good opportunity for the ceramic manufacturer.

Economic Development

In 1904 the value of the production of the natural resources of the state amounted to less than $1,000,000 and of this amount $600,000 was produced by the manufacturers of clay products. Since this time the annual production has increased to over $140,000,000 from the natural resources and at the same time the value of the clay products manufactured has decreased each year. There is no logical reason for this since the population and the wealth of the state have been increasing steadily affording a good market, and with the resources of the state offering good possibilities for the clay products manufacturers, they should have made rapid strides forward, at least keeping up with the neighboring states. As it is, all ceramic products used in Louisiana are shipped in except for part of the common brick used.

At the present time, there are 15 plants manufacturing 52,000,000 common brick annually. Of these plants two could be classed as modern brick yards and the rest using old machinery and old methods are barely making a living for their owners. The updraft kiln is used by nearly all of them, one yard having a continuous kiln and another three

rectangular downdraft kilns. Evidently little care was taken in picking their sites as to the value of the clay to be used and this, with mismanagement and old equipment has kept the clay products manufacturer of Louisiana behind his competitors.

Survey Being Conducted

Realizing this fact the Department of Conservation of the State of Louisiana instituted a survey of the clay deposits with the hope of building up this industry and helping those already started. A ceramic laboratory was completely equipped at the State University in 1926 and work begun immediately. Ceramic courses are offered at the University, and the classes have increased in size each year. Bulletins are being published covering the locations and tests of the deposits of clay, taking the state by sections. These may be procured from the Department of Conservation, New Orleans. After the entire state has been prospected, one bulletin will be published covering the best deposits within the state, and their possibilities. In the two years since the survey was started, three brick and tile plants have been constructed.

Possibilities

Louisiana, with its clay deposits and with the largest gas field in the world, gas of 1100 B.t.u., selling at a price between 10 and 20 cents per cu. ft., cheap labor, good markets, and easy transportation by means of railroads and navigable rivers combing the entire state so that it is possible to transport the raw material in as well as dispose of the finished product, affords possibilities for all ceramic manufacturers, manufacturers of glass, cement, enameled wares, china, porcelain, pottery, as well as the heavy clay products manufacturer.

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THE DEVELOPMENT OF THE SHALE PLANER[1]

By C. Forrest Tefft

ABSTRACT

The development of the shale planer from the first machine built by J. M. Powell fourteen years ago to the latest type is traced. Examples of applications at various plants are cited. Actual operating cost data on some of the latest type machines are presented. The advantages of a shale planer over other gathering machinery are discussed.

Powell Shale Planer

Fourteen years ago J. M. Powell, President of the Indiana Drain Tile Company of Brooklyn, Indiana, was having difficulty in producing a high percentage of No. 1 quality ware because of the variation in the firing shrinkage and in color of the ware, depending upon how evenly the different layers of shale had been mixed when loaded into the bank cars.

Since a uniform mixture made a good product and an uneven mixture made a variable one, Mr. Powell built a machine that cut a uniform amount of shale from top to bottom of the shale bank. This machine, the first shale planer in the United States, thoroughly mixed this cutting of shale and loaded it into the quarry car in one operation. It cut, mixed, and loaded approximately 175 tons of shale each day, and the percentage of No. 1 ware was increased considerably.

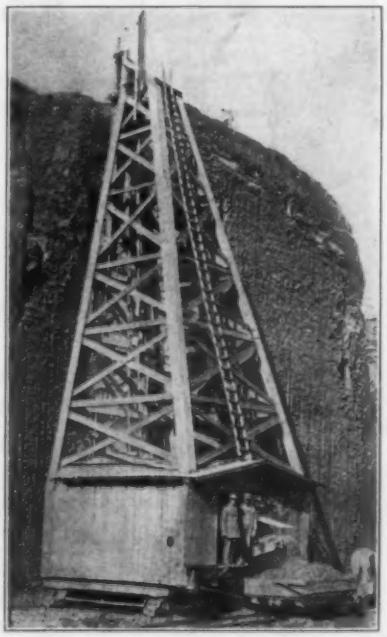

Fig. 1.—First machine.

Figure 1 shows this first machine. The tower was built entirely of wood and even the main frame work was almost all wood. The first power plant was a twenty horse-power hit-and-miss type gasoline engine. After two years this was replaced with a twenty horse-power electric motor and the cutting chain was slowed down considerably. A few months later the old wooden tower was replaced by steel.

Figure 2 shows the steel replacement of the first wooden planer. The angle of the cutting chain was increased considerably over the first design to lessen the amount of shale falling to the foot of the bank because of disintegration.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Heavy Clay Products Division.)

It is an interesting fact that while this machine has undergone many changes it is still in daily operation. Its latest development is crawler type mounting for greater ease and speed in moving about the quarry.

Because there was an insistent demand from several of Mr. Powell's friends for a "shale digger," arrangements were made late in 1914 for the Arbuckle Company of Rushville, Indiana, to manufacture and sell this new machine east of the Mississippi River.

Early in 1915, the Eagle Iron Works of Des Moines, Iowa, purchased the right to manufacture and sell throughout the territory west of the Mississippi River and in 1922 purchased the interests and rights from the Arbuckle Company.

FIG. 2.—First machine rebuilt.

Straight Planer

It was about 1915 that H. R. Straight built his planer at Adel, Iowa. This machine reversed the direction of the cutting tool from that of the Powell machine. It also introduced a circular cut designed to give greater stability to the bank and cut down the danger from slides of the shale.[2] The writer's experience has been only with the Powell machine, and no attempt has been made to obtain recent data on the development or operating costs of the Straight planer. His first experience was with a No. 22 and the machine did not stand up under the hard work required. When it was operating its product was better than that made from the same shale gathered in any other manner. Because of the operating difficulties, however, and the fact that a better product could be made from the shale too hard to be cut by the planer, it was finally abandoned.

The Eagle Iron Works developed a planer that would work in much harder shale than that cut by the older types. It cost more than the less sturdy one but it is being used in shale deposits that could not have been cut successfully by the lighter machines.

Planer on Hard Blue Shale

The outstanding example of the successful application of a planer to shale gathering is the machine in use at the quarry of the Collinwood Shale Brick & Supply Co., Cleveland, Ohio. This machine is shown in Fig. 3. It is cutting a very hard blue-gray shale that at times shows sparks from the knives much the same as the spark that comes from striking a flint with a hammer.

[2] H. R. Straight, "Planer Economics," *Jour. Amer. Ceram. Soc.*, 7 [7], 523–31 (1924).

Forged Steel Chain It was on this machine that the specially designed heat-treated forged steel cutting chain was first used. This improvement in the chain together with the development of the circular cut are without doubt the two greatest improvements that have been made since Mr. Powell's first machine was built.

The Collinwood Company states that the heat treated forged steel cutting chain has been in operation over four years and has been found so superior to the original cast chain that this feature is said to be the very heart of a successful planer.

Capacity and Results

This machine is cutting in six hours four hundred tons of a uniform mixture of shale from top to bottom of the eighty-foot bank every day in the year.

The uniform mixture has maintained an improvement of 2% or more in the rattler test of the paving brick throughout the whole period since the planer was installed.

The planer has eliminated the cost and danger of blasting this high bank and has allowed them to operate at full capacity throughout the winter.

A screen test of the shale as delivered by this planer was made by the W. S. Tyler Company. From 20 to 30% of this material was fine enough to pass through the standard screens used. While Collinwood has not taken advantage of this fact by installing preliminary screens before putting the shale in storage above the dry pans, they have experienced a material saving in the upkeep of grinding and screening equipment.

FIG. 3.—Collinwood Shale Brick & Supply Company, Cleveland, Ohio.

Collinwood claims that the planer has saved them as high as $7900.00 in one year's operation and this does not include savings in dry pan repairs and lower insurance rates on account of not using powder. Neither does it include the benefits obtained from a much more uniform product.

Los Angeles Pressed Brick Company

Howard Frost, president of the Los Angeles Pressed Brick Company, considers the shale planer one of the best investments his company ever made. The machine is cutting 400 tons in nine hours each day and the company reports costs of 5.43 cents per ton with the planer in contrast to 20.3 cents per ton with its previous methods. Based on the 400 tons daily requirement, this means a saving of $59.48 each day.

Vincent Clay Products Company

The first planer of the circular cutting type has been in daily operation for the Vincent Clay Products Company of Fort Dodge, Iowa, since it was first installed. This machine is cutting a 30-foot bank made up of approximately 26 feet of shale and 4 feet of sand rock. This company gives high praise to the economy of the shale planer.

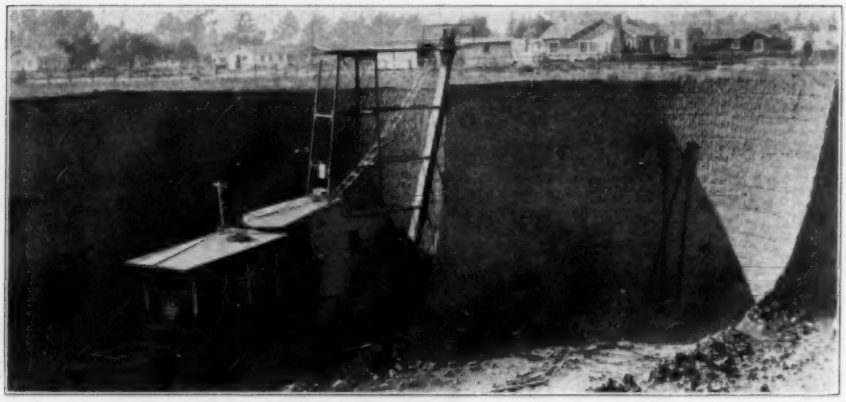

FIG. 4.—Los Angeles Pressed Brick, Santa Monica, Calif.

Claycraft Brick Company

Planer Capacity

Number 12 of the Eagle type planer was installed late in 1925 by the Claycraft Brick Company. It is required to cut in excess of 400 tons per day as it is serving two plants, one making 100,000 brick daily and the other 40,000 per day. It is operated by one man on the machine and one on the ground. As much as 450 tons of shale has been cut from a twenty-six foot bank in nine hours.[3]

Before installing the planer only one plant was operating making an average of 80,000 brick per day, using nine men to blast, load with an old type steam shovel, haul, crush, and deliver to dry-pan storage. At present no blasting and crushing are necessary. All the work of getting the shale to dry-pan storage is done by the two men at the

[3] The maximum bank height will finally be fifty feet which explains why the machine shown by Fig. 6 is so much higher than necessary for the present work.

planer and one locomotive man. One plant requires a haul of about 1500 feet and the other about 3000 feet.

Planer Storage Because of the irregular trips of the locomotive the planer was equipped with a larger storage bin (17 cubic yards) than had previously been used. The shale is delivered to this hopper by a belt conveyer driven from a three horse-power motor mounted on the steel work supporting the conveyer.

FIG. 5.—Vincent Clay Products Co., Fort Dodge, Iowa.

Hauling The haulage cars are of the drop-bottom type and are self-dumping and closing so that the locomotive operator does not leave his seat when unloading; in fact he does not stop the forward motion of the train until the load has been dumped and the gates in the bottom of the cars again closed. He then reverses his direction and goes back for another trip. This hauling equipment was "borrowed" from the coal industry and as far as is known this installation was the first of its kind in shale gathering. Each car holds $5^1/_2$ tons of shale.

FIG. 6.—Claycraft Mining & Brick Co., Columbus, Ohio.

Power Cost Actual cost records for the manufacture of 56,810,000 brick show that the electric power consumed cost 1.4 cents per ton of shale. No other system yet devised could possibly quarry, load, and crush shale at a lower power cost or give the uniform mixtures so absolutely necessary.

Repair Cost The cost of planer repairs for the manufacture of the 56,810,000 brick has run 1.6 cents per ton of shale. This figure would have been considerably lower

had it not been for two heavy slides of shale costing several hundred dollars.

The grinding plant at the 100,000 per day factory is being rebuilt, including a preliminary screen set up ahead of the dry-pan storage. Tests have shown a screening out of approximately 20% of the material. This 20% is conveyed straight to the screened storage bin. This means that the power and repairs on the dry pan for 20,000 brick out of every 100,000 made will be saved. The cost of screening and conveying this shale will not be more than if handled in the usual manner but that is a small item compared to what will be saved in the dry-pan operation.

FIG. 7.—Acme Brick Co., Oklahoma City.

Advantages of the Planer

On a basis of 100,000 brick per day the interest, depreciation, and repairs covering planer operation will run about $12.50 per day, or about the actual cost of drilling and shooting, where shovel work is being done. With an up-to-date shovel the labor cost of digging, loading, and hauling should run very close to the labor cost for the same items where a planer is used. The cost for power will be equal for the two machines of different type.

The shovel operated quarry will have higher depreciation and repair costs on the drilling equipment and shovel.

With the planer there is a saving in the crushing and grinding.

The perfect mixture of the different strata from a planer makes possible a more uniform product and smaller kiln losses.

Ability to operate in all kinds of weather and the advantages of having the shale stand in its original state rather than having it blasted down to become soaked during every rain are of advantage to plant operation.

There are conditions where the shale planer is not practical, but a decision as to whether it will work or not should not be based on the records made by the old type straight cutting light weight machines.

THE CLAYCRAFT MINING AND BRICK CO.
COLUMBUS, OHIO.

DORR CLASSIFIERS FOR CLAY WASHING[1]

By A. Anable

ABSTRACT

The Dorr bowl classifier is described in detail and its use in purifying clay is considered. The methods of purifying a North Carolina kaolin by (1) a settling flume and (2) a Dorr bowl classifier are compared. The advantages of the bowl classifier over the settling flume are (1) less labor required, (2) greater recovery of clay, (3) increased purity and greater uniformity of clay. The classifier is also applicable to the purification of secondary kaolins.

Introduction

Clay washing necessarily includes the following three stages, (1) hydraulicizing, blunging, or mixing the clay with water, (2) removal of the nonclay particles such as grit and sand and mica, and (3) dewatering the clean clay slip.

Removal of grit and sand by washing and subsequently removing the excess water from the grit-free product are steps common to many preparation processes, and to a certain extent are similar to those employed in hydrometallurgical practice. In the field of hydrometallurgy the Dorr bowl classifier and the Dorr thickener have for many years been the standard types of equipment used, first for producing uniformly fine water-floated ore particles, and second for recovering these fine particles as a dense thick sludge or slurry from which the greater part of the water has been removed.

The Classifier

The Dorr bowl classifier consists essentially of two main parts, the bowl and the washing compartments. The clay slip enters the bowl through a loading well at the center.

The bowl forms a shallow quiescent pool or settling basin which permits even the finest particles of sand to drop out, the purified slip finally overflowing as a thin film over a strip which extends around the complete circumference, forming in effect a circular weir. The size of the bowl is a function of the volume of clay slip to be handled and the retardation of the rate of flow of the slip that will cause all of the sand of a specified fineness to settle out upon the bowl bottom.

The sand deposited on the bottom of the bowl is moved toward the bowl center by plow blades attached to a set of slowly revolving radial arms. In passing into the rectangular washing compartment below the bowl through an interconnecting opening, the sand and grit is met by an upward current of water which tends to wash back into

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (White Wares Division.)

the bowl any clay which may have adhered to the sand. All of this water may be added as a spray through a perforated pipe near the discharge end of the washing compartment, and it is through this spray that the sand is raked for a final rinsing before being discharged virtually free from clay.

In the washing compartment there is a set of more rapidly moving reciprocating rakes which not only move the sand up the inclined bottom and through the rinsing spray, but also impart a rubbing and turning over motion to the sand which frees by abrasion any clay which adheres persistently. It can be seen therefore that the grit-free clay slip is allowed to overflow from the bowl in a quiescent condition in order to assist the deposition of sand, while the sand is successively passed through (1) an upward current of water, (2) a rubbing and agitating zone, and (3) a water rinsing, before it is allowed to escape from the system. It is the combination of these different treatments for the clay and the sand that assures a grit-free clay and clay-free grit as the two separated products.

Successful Installations

The first successful classifier installation was made in California washing Nevada china clay and was followed soon after by an installation at an Illinois plant which washed a local clay deposit for terra cotta use. As both of these plants were new ones there was no possibility of judging with any degree of accuracy the improvement made by using the classifier instead of the settling flumes which were highly regarded by the other clay plants in these districts. Quite recently, however, an engineering investigation was made, giving a semicommercial scale demonstration for a North Carolina clay producer; as a result of this test the client substituted a classifier for his settling flume.

This North Carolina kaolin deposit was of a primary origin as distinguished from the secondary kaolins mined on the Piedmont Plateau and in the general vicinity of Aiken, S. C., as well as in southern Georgia. These primary kaolin deposits in North Carolina contain much higher percentages of mica, quartz, and partially decomposed feldspar than the average deposit in the Aiken, S. C., and Macon, Ga. districts.

The original plant layout followed conventional lines of North Carolina practice. The kaolin was washed from the bank by a hydraulic nozzle, blunged with additional water in a beater, and passed through sand wheels and a drag scraper for the removal of coarse material. It was then run through several hundred feet of trough for the separation of the fine sand. Fine screens just ahead of the settling tanks removed

the fine mica. The thickened discharge from the settling tanks was further dewatered on filter presses, dried, and disintegrated for shipment.

This kaolin is associated with a larger amount of free silica than is usually the case. Only about 20% of the product as mined is true clay. A typical screen analysis is as follows:

SCREEN ANALYSIS OF NORTH CAROLINA KAOLIN DEPOSIT

Mesh	Per cent	Mesh	Per cent
+ 14	1.98	+ 80	1.98
+ 20	2.66	+100	5.22
+ 28	4.43	+150	10.94
+ 35	6.19	+200	7.20
+ 48	7.47	+325	10.94
+ 65	15.31	−325	25.62

The following screen tests A, B, and C indicate the character of the material shoveled out at different points. These troughs are 700 feet in length and are proceeded by sand wheels and drags which remove the sand substantially coarser than 48-mesh.

NORTH CAROLINA CLAY TROUGH OPERATION

Mesh	Sample A (from first 100 ft. of trough)	Sample B (350 ft. from sand drag)	Sample C (last 100 ft. of trough)
*+ 48			
+ 65	12.68	.88	.54
+ 80	3.87	.59	.21
+100	13.35	1.47	.75
+150	22.56	3.92	1.84
+200	17.09	11.69	8.35
+325	12.15	34.38	27.33
−325	18.29	47.15	60.95
Totals	99.99	100.08	99.97
†Clay content	10.3%	12.6%	18.6%

* +48 M Removed by sand wheels and drags.
† Determined by a washing test analogous to elutriation.

It is self-evident that the clay loss with the fine sand is appreciable.

At the experimental station, over two tons of this particular clay were run through a small scale bowl classifier. These tests demonstrated: (1) that the finished product contained less fine sand and was proportionately stronger than the clay being produced with the troughs and (2) that the loss of clay in the sand reject was reduced to 3%.

On the basis of these encouraging results, showing as they did improved product and increased recovery, a bowl classifier large enough to handle the plant tonnage was ordered to replace the trough. This machine has been operating about six months and has brought out many points of interest in connection with improved clay-washing methods.

OPERATING RESULTS DORR BOWL CLASSIFIER ON NORTH CAROLINA KAOLIN

Tonnage handled	3 tons finished clay per hr.; about same amount fine sand
Dilution (water to solids by weight) of overflow	50:1
Character overflow	95–98% −325 M (+325 M almost all mica)
Character rake product	70–80% +325 M (not more than 3–5% actual clay)
Bowl speed	1 r.p.m.
Reciprocating rake speed	12 strokes per min.
Power consumption	2 H.P.
Operating attention	One-half one man's time (supervisory only)
Uniformity of product	Maintained by uniform hydraulic and mechanical conditions
Control of product	By variation wash water and change mechanism speed or both

Savings Made

The installation of this bowl classifier has relieved three men per shift who formerly were engaged in attending to the troughs. While actual recoveries are difficult to obtain in hydraulic mining operations of this type it is safe to say that at least two tons of finished clay, which were formerly thrown away with the trough settlings, are saved per day. A gratifying feature of the operation has been the increased purity and day-by-day uniformity of the finished product, since all the sand is now being removed, whereas the old system left some in.

In conclusion it can be said with accuracy that the bowl classifier finds its chief field of utility in the ceramic field in connection with the washing of high sand content primary kaolin deposits. Nevertheless it can be used to advantage in any clay-washing operation, secondary deposits included, in which a uniform superfine product is desired and where the conventional trough system causes uneconomic labor costs and material losses.

THE DORR COMPANY
NEW YORK CITY

CERAMIC ABSTRACTS

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Abrasives

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Automatic sizing device for grinding machines. AMOS P. STEINER. U. S. 1,677,307, July 17, 1928. In a grinding machine, a wheel, a rotary work holder, a diameter gage having an arm swingable on a pivot parallel to the axes of the wheel and the work holder the arm being longer than the distance between its pivot and the unfinished work and being biased to move past the work, means for retracting a work center to release the work, and connections therefrom to move the gage into idle position remote from the work, substantially as set forth.

Grinding apparatus. JOHN A. MILLIKEN. U. S. 1,677,484, July 17, 1928. A grinding apparatus of the character described comprising relatively spaced rotatable grinders, a rotatable work holder interposed between the grinders, a power shaft for actuating the grinders, and means whereby the grinders may be adjusted with respect to the power shaft and axially of the work shaft.

Segmental ring wheel. THURE LARSSON. U. S. 1,677,866, July 17, 1928. A driving head for a grinding wheel comprising a supporting ring adapted to hold a plurality of abrasive segments around its periphery with their outer ends projecting beyond the ring to form a plane grinding surface and a set of clamping blocks adjustably mounted on the head which are arranged to clamp against the peripheral surfaces of the assembled segments, the parts being so constructed and arranged that certain clamping blocks may be moved to engage the inner end surfaces of the segments and thereby receive the thrust of the grinding operation.

Gear grinder. CARROLL KNOWLES. U. S. 1,678,293, July 24, 1928. A gear grinding machine comprising in combination, a base, a rotatable grinding wheel thereon, a work supporting spindle, means to reciprocate the spindle past the wheel, an abutment fixed during operation having a plane surface thereon, a plate mounted on the spindle and having a curved surface adapted to contact with the plane surface on said abutment, whereby reciprocation of the spindle simulates a rolling motion of a gear blank thereon, and means to radially withdraw the blank from the wheel during operation and while the abutment remains in contact with the plate to permit indexing.

Grinding machine. ALEXANDER ZÄHRINGER. U. S. 1,678,413, July 24, 1928. Machine for grinding spiral drills comprising a frame, a grinding wheel carried in the

frame, a bracket pivotally connected to the frame, and adapted to rock about an axis which coincides with the face of the grinding wheel, a support for the drill to be ground secured on the bracket and comprising a hinged flap, the axis of the hinge extending at an angle to the face of the grinding wheel, a chuck for the drill to be ground adapted to be attached to the flap, and mechanism connecting the hinged flap with the bracket so as to impart rocking motion to the bracket when the flap is turned about its hinge.

Abrasive wheel. JOSEPH L. HOWLAND. U. S. 1,678,596, July 24, 1928. An abrading wheel of the character described comprising circumferentially divided sections adapted to be associated to form the wheel, one of the sections being provided with openings, a resilient band adapted to surround the sections when associated, a flange formed with each section and adapted to coöperate for retaining the resilient band on the sections, a flexible band between the sections and resilient band, a fabric drilling for reinforcing the resilient band, an abrasive band surrounding the resilient band, and the openings being adapted to receive a tool for separating the sections as and for the purpose specified.

Grinding and polishing apparatus. PETER JOHN KNAUS. U. S. 1,678,732, July 31, 1928. In a grinding machine, a grinding wheel, a feeding wheel peripherally opposed to the periphery of the grinding wheel, means for rotating the grinding and feeding wheels, and means for supporting and guiding an article to be ground between the peripheries of the wheels, the forward portions of the wheels being profiled to abrade the article at graded depths, and the rear portions of the wheels being parallel to each other to polish the article as it passes therebetween.

Grindstone honing device. NELSON M. BAKER. U. S. 1,679,200, July 31, 1928. In combination with a grinding machine including a rotary stone, a housing arranged in front of the stone, a sleeve carried by the housing, a shaft arranged within the sleeve, a hone carriage associated with the sleeve, a cam carried by the shaft, means to connect the hone carriage and cam, and means to rotate the shaft whereby the hone carriage is reciprocated in the path of the stone face.

Cutter grinder. SOL EINSTEIN, LESTER F. NENNINGER, AND HERMAN R. ISLER. U. S. 1,679,413, Aug. 7, 1928. A grinding machine combining a frame; a grinding wheel rotatably and translatably journaled thereon; means to rotate the grinding wheel; means to support a cutter adjacent the grinding wheel and to give to the cutter six different adjustments relative to the grinding wheel to present to the grinding wheel adjacent faces of the cutter disposed at an angle of more than 90°; and means to give to the grinding wheel bodily movements to cause it to traverse the faces.

Gear-grinding machine. EDWARD W. BULLOCK AND ALTON P. SLADE. U. S. 1,679,809, Aug. 7, 1928. In a machine for grinding, curved tooth tapered gears, the combination with a rotary annular grinding member having a cross-section conforming to a straight sided rack tooth and with unbroken tooth engaging grinding faces and blank support, of a bed on which the grinding member is mounted, the bed being intermittently movable away from the blank support to permit indexing the blank, and automatic mechanism for imparting to the blank support a translatory movement and also a partial rotation about its axis whereby to roll the blank past the grinding member during operation of the latter.

Process of generating or grinding gear teeth. CHARLES H. SCHURR. U. S. 1,680,258, Aug. 7, 1928. The method of generating the involute teeth of a gear or gear blank of known base circle diameter to have a preselected pressure angle, by engagement with a tool having a working face of different pressure angle, which consists first, of so positioning the gear or blank relatively to the tool face that a tangent to the base circle intersects the tool face perpendicularly at the same point at which the tangent meets a line drawn from the center of the base circle in the plane of the tangent at an angle with the tangent

of 90° minus the tool pressure angle; and second, of rolling the gear or blank in engagement with the tool on a circle whose radius is the line from the center to the point of intersection.

Truing grinding-wheels. VEREINIGTE STAHLWERKE AKT.-GES., AND J. WILBERZ. Brit. 290,630, July 11, 1928. In a grinding machine with means for truing the grinding wheel, means are provided to bring the wheel into correct operating relationship with the work after its diameter has been reduced by the truing. The wheel is mounted on a slide movable by means of a crank-pin operated by a handle to withdraw the wheel from the work to engage the truing tool and again return the wheel to the work. When the wheel is brought up to the tool the throw of the crank-pin is adjusted by a screw so that the wheel is trued properly. Owing to the increase in the throw of the crank, upon throwing over the lever the tool will again come into the correct operating position; stops limit the movement of the lever to 180°. The wheel may be mounted on a rocking arm of variable length instead of upon the slide.

Grinding milling-cutters, screw thread cutting tools, etc. VEREINIGTE STAHLWERKE AKT.-GES., AND J. WILBERZ. Brit. 290,631, July 11, 1928. Apparatus for grinding milling-cutters or other tools for cutting screw-threads, consists of a spindle upon which the cutter is mounted, and which may be rotated by a pulley or oscillated by a variable-crank drive and a steel band drive, clutches serving to throw in the drives or to stop the spindle, the member being stationary. In order to grind successive cutting-teeth to give first a central cut, then cuts on opposite flanks of the thread, and finally a cut of the shape of the completed thread, the spindle is connected through a dividing-head to a sleeve having a thread of the same pitch as the cutter, and by rotation of the dividing-head through more or less than 360°, successive teeth are ground to cut the thread in the manner stated above.

Molding grinding stones. M. C. HUTTO. Brit. 290,848, July 11, 1928. Abrading devices made from granular materials are compacted uniformly by placing them in a mold, subjecting them to a preliminary light pressure by means of independent pressing-members acting on different portions of the surface, striking off the mold and finally subjecting the remaining compacted material to the final pressure in the molding machine.

Grinding conical, concave, and convex forms. O. WALDRICH. Brit. 290,942, July 11, 1928. In grinding conical, concave, or convex work pieces in which longitudinal (axial) movement of the wheel is coupled by gearing to advance or withdraw the wheel in transverse direction the backlash in this transverse movement is cut out by delaying, during the change over, the longitudinal movement for a little, so that the action only sets in simultaneously with the transverse movement.

Art

Art glassware of Czechoslovakia. THEODORE WOLFRAM. *Ceram. Ind.*, **11** [2], 142–48 (1928).—A history of the Bohemian art glassware is given. The centers of glass production remain the same as in the past; the frontier regions of Bohemia, particularly the northern (Hajda and Kamenicky Senov), the Mountains of the Giants, and the Forests of Bohemia. The methods now in use for the fabrication and decoration of goblets are much the same as those of former days, except that the mechanical developments and the use of coal allow mass production and wholesale dealings. Through their own workrooms and the many home-workers they employ, they always have at their disposal as many crystal workers and engravers as they may need. The work is carefully divided among the specialists, and the rough glass, before reaching the market, passes through several different hands; crystal-workers, molders, engravers, painters, and gold-leaf workers. Besides the clear glass with a potash or lead base, ornamented

with cut brilliants, the refiners of today have created quantities of colored glass as well as new effects by the combinations of these colors and perfection in cutting and engraving. Besides the Industrial Art Schools in Prague, there are three special schools for glass artisans in Czechoslovakia. The Museum of Industrial Arts in Prague, which contains the famous Lana collection, has the richest and finest exposition of glass in Europe. The best-known artists, architects, and other technical geniuses of the country are continually collaborating on means for the improvement and advancement of the art glass industry of Czechoslovakia and the government encourages manufacturers, exporters, and workmen in every way possible. F.P.H.

Uranium red glazes. ARULF HOLL. *Keramos*, **7** [10], T4 (1928).—The composition and firing of glazes containing uranium are discussed. F.P.H.

Gauguin and Durrio, artists. GABRIEL MOUREY. *Creative Art*, **2** [4], 284–85 (1928).—The Danish sculptor, Jean Gauguin, son of Paul Gauguin, has been invited by Sèvres to work in the shop producing statuettes in stanniferous faience. The Spanish potter, Francisco Durrio, said to be the most remarkable individual ceramic artist, is an architect, sculptor, goldsmith, and maker of jewelry. M.G.W.

Glass design in Holland. DORA E. HEDGES. *Creative Art*, **2** [4], 286–89 (1928).—V.A.N.K. or Dutch Society of Applied Arts and Industry is similar to the Design and Industries Assn. in England or Werkbund in Germany. These organizations employ artists in industry, encouraging design in production, as well as mechanical production. M. Cochius, head of the Leerdam glass factory, employs as designers architects, such as de Bozel and Berlage, and potters such as Lanooy de Lorn and A. D. Copier. Cochius worked in the factory first as a "hand" from the age of 16 until after studying design, and has combined art and crafts, reaching the position of designer-craftsman. He designed the utility glass introduced into England three years ago under the name of Lobaco glass. Exhibition in London is at Merchant Adventurers. "Unicas," unique pieces, as the name implies, are in color and iridescence. M.G.W.

Check-stamped pottery from Alaska. H. B. COLLINS, JR. *Jour. Wash. Acad. Sci.*, **18** [9], 254–56 (1928).—In America, check-stamped pottery as an archaeological type is restricted to the south Atlantic and Gulf regions and the only modern Indians known to have made it were the Cherokees. The finding of samples of this work in Alaska is rather surprising. As far as ornamentation is concerned, the pieces are identical with those found in Louisiana. The ornamentation was produced by applying to the soft clay a wooden paddle or stamp on the surface of which was carved a checkered pattern. The only significance attached to these findings is to show how two wholly unrelated cultures have produced an identical result. The manufacture of pottery is no longer practiced among the Eskimos but the process has been described by an old Eskimo as follows: A quantity of clay, procured from certain localities on the tundra, was reduced to a smooth paste by mixing with walrus blood and kneading it with the hands. A quantity of sand from the beach was added, together with fine feathers from the breast of the ptarmigan. From this material the vessel was built up by means of the hands with the aid of a flat piece of wood shaped like a paddle. Sometimes the exterior was finished smooth and either left plain or decorated with incised lines and dots by means of a pointed stick. Instead of a smooth finish a pitted surface was sometimes produced by means of a roughly carved paddle or by wrapping the unbaked vessel in a piece of grass matting which left its impression. The finished product was then baked in a wood fire. Women, and not men, were engaged in this industry. A.J.M.

How glass is made. III. Decorating glassware. D. KING IRWIN. *Crockery and Glass Jour.*, **106** [12], 24 (1928).—The earliest decoration of glass was with the addition of colors. Engraving on a stone wheel and diamond point engraving and cutting followed; etching by acid came later. Cutting is really grinding on a revolving wheel of

stone, with water dripping on it. The smaller indentures and details are added and the whole buffed or polished on the polisher's wheel. Etching is produced by the action of hydrofluoric and other acids upon an article which has previously been coated with wax in order to protect from the acid all portions of the glass except the desired design. Needle etching is one of the most common processes. By an intricate device of cams and wheels a set of needles trace a design in the wax. When the article is dipped in the acid, the glass is attacked through this tracing. Pantograph etching is somewhat similar, except that the design, greatly enlarged, is produced on a steel plate. Deep-plate etching produces the most beautiful effects. Here the design is etched in a steel plate exactly the size required and in curves to fit the article to which it is to be applied. The indentations in this plate are filled with an acid resist called ink; from the plate they are transferred to paper. The design in this resist paper is then applied to the glass, the ink adhering when the paper is withdrawn. The article is then painted around the design with hot wax, and immersed in acid. E.P.R.

When art goes to work for trade. ANON. *Crockery and Glass Jour.*, **106** [12], 28–29 (1928).—The International Exposition of Art in Industry was held by R. H. Macy & Co., Inc., of New York, May 14–26, 1928. The growing importance of glass and ceramics in modern decoration was noted. The purpose of the Exposition was to dramatize the entry of the world's great creative artists into the field of design for commonplace objects of every day use, and to show how the artist and artisan are now working together to make the products of this age beautiful as well as useful. E.P.R.

Ceramic exhibit at the Metropolitan Museum opens in October. ANON. *Pottery, Glass, and Brass Salesman*, **37** [25], 27 (1928).—Two large exhibitions have been planned by the Metropolitan Museum of Art: (1) an international exhibition of ceramic art in October, and (2) an exhibit devoted to American industry early in 1929. E.P.R.

Mosaics of the Baptistry at Florence. ANON. *Daily Mail*, June 26, 1928.—The historic Baptistry is so dark that only at noon has it been possible to view the beautiful 13th Century mosaics with which the cupola is encrusted. In the future the dome will be lighted by 23 lamps of 400 candle-power. The mosaics, which are the work of Gaddo Gaddi, Andrea Tafi, and others, center round a gigantic figure of Christ above the high altar, and represent, on a gold background, the Day of Judgment and scenes from the life of Christ and of John the Baptist. H.H.S.

Colored glasses. W. M. HAMPTON. *Chem. Age*, **18** [456], 264 (1928); *Chem. and Ind.*, **47T**, 192–96 (1928); for abstract see *Ceram. Abs.*, **7** [6], 342 (1928).

Decimal classification of colors. A. RUTHARDT. *Farbe u. Lack*, p. 116 (1928).—The ten colors, including black and white, are designated by the numbers 0 to 9. The amount of color is indicated by numbers following the first one and is expressed as parts of color per 10 or 100 parts of inert. Thus, 25 means 5 parts of color 2 plus 10 parts inert. Mixtures are separated by commas. Thus, 255,615 means 55 parts color 2 plus 100 inert, mixed with 15 parts color 6 plus 100 inert. The predominating color is written first. (*C. A.*)

Medieval glazing accounts. L. F. SALZMAN. *Jour. Brit. Soc. Master Glass Painters*, **2**, 116 (1927–28).—Notes on entries throwing light on the history of glasswork, made while going through all the building accounts, down to 1540, preserved in the "Exchequer K. R. Accounts," at the Public Record Office, London. The first entry was dated 1221. (*J.S.G.T.*)

Panel of 16th Century stained glass representing the temptation of St. Anthony. C. H. HITCHCOCK. *Jour. Brit. Soc. Master Glass Painters*, **2**, 121 (1927–28).—A French panel of Renaissance stained glass (31x58 inches) bought cheaply by the author at the famous Heilbronner sale, in June 1921, at the Georges Petit Galleries, Paris. The panel

is one of the few examples of the Temptation of St. Anthony depicted in an ancient window. (Illustrated.) (*J.S.G.T.*)

A panel of glass by De Caumont, glass-painter of Louvain, recently restored to the Abbey of Parc by Wilfred Drake. ANON. *Jour. Brit. Soc. Master Glass Painters*, **2**, 129 (1927–28).—The panel (illustrated) represents the arms of Jean Masius, the 31st Abbot of the Premonstratensian Abbey of Parc near Malines, who in 1635 gave an order to Jean de Caumont (1603–1659) to provide 41 windows for the cloister. The windows took four years to complete, and were erected in 1641 and 1642. They remained *in situ* until 1828, when, owing to the suppression of the religious orders in Belgium, the Abbey was forced to sell the glass and a large part of the library. They were bought by M. Dansaert of Brussels for 18,000 francs, the original cost being 2640 Rhenish florins. On the death of M. Dansaert the collection was dispersed. One panel found its way to the Grosvenor Thomas collection, the panel restored by Wilfred Drake to its original home. (*J.S.G.T.*)

Glass painters of Birmingham. II. JOSEPH HORNBLOWER (and others). *Jour. Brit. Soc. Master Glass Painters*, **2**, 131 (1927–28).—The following individuals and firms are mentioned: (1) Joseph Hornblower, who started about 1764. He was probably the instructor of (2) Francis Eginton, who began to paint glass in 1784. (3) F. and C. Pemberton, who in 1849 referred to Eginton as "the great reviver of modern glass-painting." (4) Chance Brothers & Co. The managers of their glass-painting department included Bontemps (about 1849), H. Jones, and S. Evans (best known for his "Robin Hood Window," (1862). (5) R. Henderson, who started about 1820. (6) J. Hardman and A. W. Pugin, who became associated in 1837. They were assisted in their growing business by two sons of R. Henderson, Hinckley, Edward Pugin (son of A.W. Pugin), and F. W. Oliphant (who was at one time associated with S. Evans, already mentioned). (7) Stock and Sharp. Reference is also made to Wailes of Newcastle and to W. Warrington of London, who made successful windows from A. W. Pugin's designs. A bibliography is appended. (*J.S.G.T.*)

A history of the York School of Glass Painting. VI. Secular character of York work. J. A. KNOWLES. *Jour. Brit. Soc. Master Glass Painters*, **2**, 136 (1927–28).—There was not a single carving of any religious subject in the Minster. Shields were everywhere. Heraldry replaced religious emblems, even on the furniture of the altar. Scenes from Biblical history were comparatively few, except in the case of the Great East Window with its 108 scenes from the Bible. These, however, were probably only used because of the difficulty of finding from any other source a series of subjects sufficiently extended to fill so large a space. On the other hand, the Chapter House, a secular and unconsecrated building, contained in three windows more subjects from Holy Writ than all the rest of the windows in the nave, choir, lady-chapel and transepts put together. (Illustrated.) **VII. Characteristics of the York type of design.**—York work had a strong local feeling about it. It was done by Yorkshire designers and craftsmen, working for the people of Yorkshire and the north. Painted glass was valued chiefly for its decorative rather than for its subjective or instructional value. The rivalry between York and Gloucester as to which could show the largest east window dated back to the time when their respective choirs were built. As to the design of the glass itself, it was unlikely that there was any great divergence from the work of other English schools (or even from contemporary work on the Continent) until the 14th Century. The design at all periods was usually founded on the mechanical construction of the window, that is, on the iron bars. At York, upright bars or standards were rare, probably because they interfered with the freedom of the glass designer. Windows were generally divided by heavy T-bars, spaced so as to form compartments practically square. Into these the panels of glass were fitted. Examples are given and mention

made of the method of filling windows with alternate bands of contrasting white and color. York designers sometimes put a row of donors, or of subjects from the life of a saint across the top of the lights instead of across the bottom, as is the usual practice. (*J.S.G.T.*)

PATENTS

Steel printing body and method of producing the same. HELENA S. SADTLER. U. S. 1,678,231, July 24, 1928. The methods of producing steel printing bodies, which consists in subjecting the same to a hardening process including the addition of carbon to carbonize the same, grinding and polishing the hardened body to provide the same with a true and even surface, and thereafter etching the surface to form characters or designs thereon.

Imitating frosted or stained glass, etc. R. GOLDSCHEIDER AND I. TUSCHINSKY. Brit. 286,012, April 18, 1928. Imitations of frosted or stained glass, etc., are produced by impregnating a fabric with lacquer, and applying a layer of granulated glass or glass beads to both sides of the fabric, or alternatively, by mechanically working the surface of the lacquer on both sides, so as to produce a dense mass of small protuberances thereon. The lacquers used are preferably those known under the registered Trade Mark "Schellan," and consisting of condensation products of urea and formaldehyde. The glass granules may be covered with a second layer of lacquer. The mechanical working of the surface may be effected by means of rollers, or by projecting sand against it. The fabric may consist of wire gauze, the meshes of which are filled with lacquer, and decalcomania pictures or the like may be applied to the surface. Pattern effects resembling bead embroidery can be obtained by printing or painting the fabric after its impregnation with the lacquer, or by applying decalcomania pictures thereto.

Cement, Lime, and Plaster

Cement in 1926. B. W. BAGLEY. *Bur. Mines, Mineral Resources of the U. S.*, Part II, pp. 303–34 (1926).— The production of Portland cement in 1926 was 164,530,170, barrels, the greatest quantity manufactured in any year. The report covers the following subjects: chief hydraulic cements; hydraulic cement plants; Portland cement; production, shipments, and stocks; domestic consumption; local supplies; prices; manufacturing conditions; masonry, natural and pozzuolana cements; imports and exports; and cement production in Canada. R.A.H.

New cement burning furnace. ANON. *Chem. Age*, **18** [457], 294 (1928).—A patented cement-burning furnace which possesses some quite new and apparently valuable features has recently been evolved in Germany. The new conelike rotary chamber makes it possible not only to obtain a perfect calcination, but also a better sintering than is obtainable in the ordinary rotary cement furnace, and effects this in two stages. The primary sintering occurs while the fine material is in suspension in the furnace, and the secondary sintering is of the same kind as that in the ordinary cement furnace; this secondary sintering may be regarded as a measure of insuring that no part of the charge escapes being sintered. The hot zone of the furnace, which is about 3 meters in length, can be brought near to the highest possible theoretical temperature. If, therefore, a suitable refractory material is used for the furnace interior lining, the high-grade alumina and other cements can be produced in a very economical way. A further advantage over the ordinary cement furnace is claimed in the much better regulation possible, which permits a very considerable reduction in the cost of operation. In the usual long cylindrical form of cement furnace the different temperature zones of the furnace fluctuate, according to the relation of the chimney draft to the furnace pressure in rather wide limits, and this causes a corresponding fluctuation in the bedding of the burning raw material. In the new furnace with its quick-changing furnace section such

fluctuations do not occur, as an equilibrium between furnace pressure and chimney draft is reached too quickly. The fuel consumption of the new furnace as compared with the ordinary cement furnace is about one-half for the same output of cement clinker, and by strict attention to the regulation can be still less. The power requirements for rotating the furnace are much less and the total costs of operation are said to be only a fraction of those in ordinary cement furnaces. The great advantages of this new form of cement burning furnace indicate that it will become widely adopted in the near future. R.F.S.

Alumina cement in practice. FRITZ BUECHI. *Beton u. Eisen*, **27** [9], 174–78 (1928); *Rock Prod.*, **31** [15], 84 (1928).—B. describes the behavior of alumina cement in its application in various mixing proportions to concrete and mortar. Alumina cement was first patented in France by J. Bied as *ciment fondu* or *cement electrofondu*. At the close of the last year the Société de Lafarge et du Teil produced an average of 165 T. of *ciment fondu* per day. Its manufacture, however, has recently been extended to other plants, bauxite being used as the principal raw material. The compositions of the ciment fondu and of the so-called Alca-Schmelzzement of the Elektrozementgesellschaft compare with the ordinary Portland cement as follows:

Element	Ordinary Portland	Alca cement	Ciment fondu
SiO_2	18–26%	10.11%	9.03%
TiO_2		1.74	
FeO	1–6	4.25	5.60
Fe_2O_3		1.80	0.97
Al_2O_3	4–12	42.31	40.48
CaO	58–66	38.80	41.50
MgO		0.61	0.56
SO_3			0.66
S		0.24	0.42
Ignition loss			0.43

B. made tests to determine the consequences of an unsuitable application of alumina cement in concrete, to chart the flexual strength, the tensile strength, and the degree of adhesion to steel reinforcement of alumina cement of various proportions of mixture and various ages, and to find the reciprocal adhesiveness of concrete made with alumina cement and of concrete made with Portland cement. The test beam which he has employed may well replace the compression cube samples in conducting tests. F.P.H.

Literature on setting and hardening processes in Portland cement. R. H. BOGUE. *Rock Prod.*, **31** [16], 67–70 (1928).—A discussion is given of the crystallization and the colloid theories. Both theories for the setting and hardening of cements have had their champions, and likewise serious difficulties have been shown to follow the too rigid adherence to either of these unmodified theories. The present tendency seems to be to accept the general principles of the crystallization theory as set forth by LeChatelier and by Donnan, but to recognize the important part played by the amorphous material, as shown by Michaelis and by Kuhl. A large part of the difficulty in the mutual understanding of the two points of view is dispelled by a close examination of the theories and of the behavior of the products in question. As emphasized by Desch and by Hatschek, a closer definition of the exact significance of the terms colloid and crystalloid leads to the assurance that in the end the same forces and processes are implied, but only that the emphasis is placed on different aspects of the phenomena. For preceding abstract see *Ceram. Abs.*, **7** [8], 512 (1928). F.P.H.

Modern lime kilns. ANON. *Stone Trades Jour.*, May 1, 1928; *Rock Prod.*, **31** [16], 102 (1928).—A lime kiln of an interesting type from the point of view of production and consumption of fuel recently commenced work at the late National Nitrogen Works of Chorzow (Upper Silesia). It is a shaft kiln comprising an inner central part or core for

heating with a coal-gas producer. The height of the kiln is 25 meters (82 ft.), the diameter at the mouth 3 m. (9.8 ft.), and the largest diameter at the zone of combustion 6 m. (19.6 ft.). The maximum diameter of the core is 4.3 m. (14 ft.), thus leaving a space between the core and lining of the kiln of 0.88 m. (2 ft.). In the cooling section of the kiln the diameter of the core is reduced to 3.4 m. (11 ft.), so that the free space is then 1.30 m. (4 ft.). The total capacity of the kiln, the core being deducted, is 290 cu. m. (277 cu. yd.). There are six openings to draw the kiln, 0.6 by 0.7 m. (23 by 27 in.) regularly arranged at the exit from the cooling section. Each opening is closed with a folding trap. The lime is drawn out automatically and continuously. There is an endless track in the space below the drawing openings on which an electric truck runs and opens each trap as it moves forward. The lime falls into the truck and the trap shuts automatically. The length of time during which the trap is open can be regulated as required, as also the speed of the truck, to increase production. The lime is automatically discharged from the truck into a pit from which it is carried by a bucket chain to the silos. F.P.H.

Volcanic ash for producing hydraulic mortar. H. AND W. BRINTZINGER. *Zeit. anorg. allgem. Chem.*, **168,** 93–95 (1927); *Rock Prod.*, **31** [16], 102 (1928).—Ashes of the volcano Acatenango in Guatemala were tested and mixed with burned lime, set with the same quantity of water, formed, and then subjected to the prescribed tests for strength of compression. The compressive strengths were found to be from 68 to 114 kg. per sq. cm. (967 to 1621 lb. per sq. in.), and accordingly such mixtures cannot be used for high-grade mortar. The 0.5% sulphur content of the mixtures oxidizes through the influence of air and moisture to sulphate, which forms calcium-aluminium sulphate with free calcium oxide still present and aluminium hydrate of the mortar. Since this reaction includes a change in settling and hardening of the mortar, it causes, the appearance of blooms, which, with larger quantities of sulphur in the raw material, could lead to crack formation, and in smaller quantities it could still lead to a considerable subsequent decrease in the strength of the mortar. In test samples, which had lain 15 months in a damp atmosphere, the strength had decreased 15 to 20%. F.P.H.

Influence of lead oxide upon the hardening of Portland cement. B. GARRE. *Zeit. angew. allgem. Chem.*, **169,** 305–308 (1928); *Rock Prod.*, **31** [15], 85 (1928).—G. describes first of all the various influences that destroy cement and concrete. A salt content of several per cent in the makeup water does not cause much change in the characteristics of the cement; 10 to 50 g. of NaCl per liter has no strong influence, 0.1 to 0.25% sugar, 1 to 2% glucose, and 2% tannic acid have but little influence. A 3% solution of calcium chloride increases the strength of concrete after 28 days of combined setting from 331 to 500 kg. per sq. cm. (4708 to 7112 lb. per sq. in.). Salts which react neutral can be used up to high percentages. Addition of 1/1000% of lead oxide influences cement very much because a strong retardation of the setting process starts in. Increased additions retard the setting period still further. With a content of 1% of lead oxide only, an exceedingly slight hardening sets in and under water there takes place a complete dissolution of the cement. F.P.H.

Burning process in the automatic shaft kiln. H. KÜHL. *Zement*, **17** [22], 859–62 (1928); *Rock Prod.*, **31** [16], 102 (1928).—Upon the basis of his tests K. arrived at the following conclusions: Even though it is true that carbonic acid from the pulverized raw material and the briquetted fuel are able to react with each other from about 500 to 600°C (932 to 1112°F) upward, this reaction is not of decisive significance in the burning of the briquetted fuel and cement material in the automatic shaft kiln. The burning of the fuel pressed into the raw cement material briquet takes place by the direct influence of the atmospheric air upon the burning fuel in a temperature zone which lies far above the dissociation temperature of the calcium carbonate. The burning speed of the

briquetted fuel is first of all dependent upon the prevailing temperature and obviously less upon the size of grain of the burning material. The diffusion process within the highly heated raw stone appears to be so active that the size of the briquet is likely not to be of decisive significance in the rapidity of the burning process. F.P.H.

Lime in flotation. S. E. STEIN. *Eng. Min. Jour.*, **125** [12], 487–89 (1928).—Lime as a flotation agent belongs to the class which includes such agents as caustic soda, trona, soda ash, and sulphuric acid. Lime functions as calcium hydroxide after being dissolved in the mill-circuit water. It is added as (*a*) burnt lime, (*b*) hydrated lime, or (*c*) milk of lime, a water suspension of hydrated or freshly slaked lime containing about 25% solid. The effective portion of the added lime is that which goes into solution in the mill-circuit water to react as calcium hydroxide and its magnitude will be governed primarily by the quality of the original limestone and the efficiency of the burning. Very little is known about the reaction by which lime accomplishes its purpose in flotation. A.J.M.

Cement works in England. T. L. BAILEY. (64th Ann. Rept. Alkali Inspector.) *Chem. and Ind.*, **47,** 748 (1928).—The 43 plants have mostly been fully employed throughout the year. The number of rotary kilns is increasing, and some of these are now 300 ft. in length. Excessive dust discharge from the works chimney has caused local nuisance in some localities, by reason of failure to catch fine dust produced by a modification of former kiln practice. Steps were taken to reduce this fine dust by returning it continuously to the system. H.H.S.

Cement in Scotland. J. W. YOUNG. (Ann. Rept. Alkali Inspector for Scotland). *Chem. and Ind.*, **47,** 770 (1928).—At Glasgow cement dust is recovered by an electrostatic process. (See preceding abstract.) H.H.S.

German cement industry. ANON. *Chem. and Ind.*, **47,** 753 (1928).—The output of Germany during the first quarter of 1928 attained the record amount of 1,498,000 T., and production continues to grow, particularly of ferro-Portland cement, the cheaper grades showing a decline. Exports are at the rate of over 100,000 T. a month. H.H.S.

Cement-making activities over a decade. ETIENNE RENGADE. *Ciment*, **32,** 407–13 (1927).—An account of the technical development of fused cement and of some of its properties. Lime or Portland cement is harmful but this cement is less affected by gypsum than other cements. Its resistance to the solvent action of pure water, sirups, sugar solutions, and vegetable or mineral oils is discussed. The limit approached for the compression-tensile strength ratio is 13.5 for aluminous cement and 10.6 for super Portlands. A description of modern cement mill apparatus is given. (*C. A.*)

Knowledge of the constitution of aluminous cements. CHARLES BLANCHET. *Rev. mat. constr. trav. pub.*, **219,** 397–402 (1927); **220,** 8–14; **221,** 44–48 (1928).—A review of the literature covering the silicates and aluminates of Ca. Some of the effects on aluminous cement of ferric oxide, methods of burning and of cooling are considered. (*C. A.*)

The reactions during the first part of firing a calcareous-argillaceous mixture for Portland cement. E. MONATH. *Rev. mat. constr. trav. pub.*, **222,** 81–86 (1928).—Mixtures heated in a small furnace at various temperatures up to 1000° were analyzed. Free CaO was found first at 750° and reached a maximum at about 920°, at which point the insoluble residue began to fall off. (*C. A.*)

Electrical method for measuring the setting time of Portland cement. YOSOMATSU SHIMIZU. *Science Repts., Tohôku Imp. Univ.*, **17** [1], 85–92 (1928).—The electric resistance of Portland cement changes suddenly at the moment of final set, and this is used as a means for determining setting time. A constant temperature bath is used and the conductivity is determined with Pt electrodes and a Kohlrausch bridge, specific electric conductivity $K \times 10^4$ being plotted against time. Curves are shown for Portland

cement at 18, 25, 30, 35, 40, and 50°, the rate of setting being greatly influenced by temperature. Thus at 18° the time of setting is approximately 475 min. and at 50° approximately 270 min. (*C. A.*)

Cements used in heavy chemical manufacture. H. B. BISHOP. *Trans. Amer. Inst. Chem. Eng.*, **19**, 9–12 (1927).—A tabular résumé. The types are: those for bonding bricks; those applicable for chemical stoneware and fused silica; and those adapted to metal joints. (*C. A.*)

BOOK

Cement, Limes, and Plasters. EDWIN C. ECKEL. 3rd ed. John Wiley and Sons, New York, 1928. 699 pp. $7.00. Reviewed in *Min. and Met.*, **9** [259], 399 (1928).—In this third edition it has not been as necessary to revise the mass of the book dealing with the cements known in 1922 as it has been to take up the types of cement that have come into general use since that date. A section has been added dealing with the alumina cements and accelerated or high-strength Portlands. Having been rather actively associated with some of these new developments, E. presents complete and exact data on all new cements. F.P.H.

PATENTS

Method of manufacturing cements rich in alumina. ALEXANDER HASSELBACH. U. S. 1,677,182, July 17, 1928. The method of manufacturing cements rich in aluminium, consisting in introducing the raw mixture together with a small percentage of fluorspar into a rotary kiln and carrying through the burning procedure at a temperature lying below the melting temperature at present employed in making cements without the addition of fluorspar.

Shaft kilns. GEOFFREY MARTIN. Brit. 276,066, Oct. 5, 1927. In a shaft kiln for the manufacture of lime, gypsum, and cement, and for the calcination of ores, etc., in which the materials in powdered form are allowed to fall through an ascending stream of hot gases, the average speed of the gases in the clinkering or sintering zone of the kiln is at least four times that of the gases in the preheating or decarbonating zone. By operating in this manner the fine particles are retained in the cool zone until a number of them have fused together to form particles of sufficient weight to overcome the speed of the gases in the high temperature zone. The cross-sectional dimensions of the preheating-zone are greater in both directions than those of the slit-like clinkering-zone, the cross-sectional areas of the two zones being in the proportion of ten to one. The kiln is fired by lateral burners situated at the base of the clinkering zone and beneath the burners is a cooling zone through which the air for combustion is passed. The clinkering zone opens into the preheating zone at the side remote from that through which the raw materials are supplied, so that the whirling streams of gas will tend to carry the finer particles downward. The kiln may be sunk in the ground or built up against the face of a quarry.

Cement kilns. GEOFFREY MARTIN. Brit. 282,868, Feb. 22, 1928. The output of a rotary cement kiln is increased by causing the gases to pass therethrough at a speed substantially greater than that normally maintained. Preferably a speed of not less than 30 feet per second is maintained in the clinkering and decarbonating zones, and 22 feet per second in the drying-zone, as compared with 22 and 16 feet per second respectively in normal working. The increased speed may be maintained in only some of the zones of the kiln, while the speed of the gases in other zones may be normal or lower than normal. The gases may be drawn through the kiln by a fan, which is protected from overheating by sprays or jets of water, or by passing the gases first through a waste heat boiler. Alternatively water may be injected into the issuing waste gases to cool and force them out of the kiln. Variations in speed may be produced by varying the cross-sectional area of the kiln in different zones.

Manufacture of cement. E. C. R. MARKS. Brit. 290,890, Sept. 26, 1927. Volume-constant Portland cement of improved tensile strength is obtained by subjecting normal cement clinker to one or more burning operations after it has been ground and mixed with lime, calcium carbonate, etc., in quantity not exceeding that required for the formation of tricalcium silicate, and, if desired, gypsum. (*B.C.A.*)

Production of Portland cement. SERTO SNYDER. Ger. 457,116; *Rock Prod.*, **31** [15], 85 (1928).—The invention recently patented in Germany makes possible the utilization of the widely spread natural occurring crystalline silicic acid for the production of Portland cement. Sand in its natural state is mixed with the necessary amount of limestone to form calcium silicate. Small amounts (approximately 2%) of iron oxide, in the form of roasted pyrites and chromium oxide or copper dioxide are added. It is important that careful workmanship accompany the preliminary operations with reference to the fine grinding and careful mixing of the raw materials. The cement produced in this manner is free from the easily attacked calcium aluminate and possesses considerable resistance against the chemical action of sulphur water, bog water, sea water, dilute acid solutions, etc. It develops excellent strength, particularly in regard to tensile strength. F.P.H.

Enamels

New driers reduce operating cost in enameling plant. ANON. *Ceram. Ind.*, **11** [2], 153–54 (1928).—Three developments in the plant of the Chicago Vitreous Enamel Products Co., have done much to increase the production of their enameling department. One piece of equipment is a continuous chain sprayer and drier, another is a continuous drier for sheet iron, while the third is a circular cast-iron drier. F.P.H.

Cutting stencils electrically. ANON. *Ceram. Ind.*, **11** [2], 154 (1928).—One of the most recent movements in the ceramic field is the application of electric controlled devices for cutting stencils used in sign work and in the application of enamels. A large enameled sign company, formerly employed 17 stencil cutters, and has reduced the force to two girls and the automatic appliances. Where four or five men were employed for spraying the enamel, one girl with the aid of electrically controlled spraying machinery does the work. F.P.H.

Antimony in enamel: Poisoning cases. L. R. MERNAGH. *Chem. and Ind.*, **47,** 774 (1928).—At Newcastle, England, 50 people have been poisoned as a result of Sb being dissolved from an enameled vessel containing lemonade. M. holds that pure Sb oxide, correctly fritted, is an absolutely safe ingredient of an enamel, and states that most British manufacturers are using this substance. He asks for inquiry as to the origin of the vessel concerned. H.H.S.

Heat treatment of ferrous metals. C. M. WALTER. *Chem. and Ind.*, **47,** 791–96 (1928).—W. deals with the manner in which the mechanical and physical properties of cast iron, wrought iron, and steel, are affected by the heat treatment to which they are subjected, especially in their final state. The influence of C and of special elements Ni, Cr, W, Mo, V, and Co, is considered, and the study of the critical thermal points by heating and cooling curves is elucidated. Twenty-one microphotographs accompany the article. H.H.S.

Trend of engineering development in steel. B. D. SAKLATWALLA. *Chem. and Ind.*, **47T,** 198–202 (1928).—S. notes the distinct difference between the science of metals and the science of applied metallurgy. Sufficient service data should now be available to form the basis of a science of applied metallurgy. The inadequacy of test evaluations is discussed. Work should be directed to the development of correlation between test and service. A rational abrasion or wear test has not been developed. The criterion of Brinell hardness is not consistent when wear has to be evaluated. Our knowledge

of the properties of iron alloys at high temperatures is still very limited. Cinematographic studies show how steel fails under certain conditions, and how failure progresses. H.H.S.

Electric enamel firing furnace. A. D. DAUCH. *Amer. Enameler*, **1** [2], 3–4 (1928.)—The most efficient type of electric furnace for enameling has its heating units divided into two groups under separate control. The lower group which must supply heat to the firing tools, is operated about 100° higher in temperature than the upper group. M.E.M.

Fineness of grinding wet enamels. R. H. TURK. *Amer. Enameler*, **1** [2], 11–12 (1928).—The importance of uniform grinding is stressed. Transparent frits must be ground finer than opaque frits, to secure uniform colors. Finely ground enamels fuse more readily, but are more apt to crawl than coarse enamels. Sheet-iron enamels for dipping should be ground coarser than for spraying. M.E.M.

Cast iron and porcelain enameling. H. G. WOLFRAM. *Amer. Enameler*, **1** [4], 3–6 (1928).—Cast iron for enameling should be given special attention while dry. Poor foundry practice can produce castings impossible to enamel. M.E.M.

Circular annealing furnace produces good results. J. STRAUSS. *Foundry*, **56,** 299 (1928).—A furnace built by U. S. Naval Gun Factory is about 26 ft. in diameter and covered with a one-piece roof weighing 25 T. The floor is divided into quadrants, with a different number of flues in each quadrant, and each quadrant under separate damper control. Four oil burners supply the heat, which is all under the floor. Advantages of the furnace are elimination of cold corners and cold floor, economy of floor space, single lift for roof removal, uniform temperature rise, fuel saving. Photographs and a cross-section drawing are given. M.E.M.

Twinlike crystals in annealed α-iron. HUGH O'NEILL. *Iron Steel Inst.* (advance copy), 9 pp. (1928).—In examining with the microscope a coarse-grained high-purity decarburized steel plate, strained and annealed, a grain that looked like a twin was found near a sclerometer scratch on a ferrite crystal about $^3/_8$ in. square and $^1/_8$ in. thick. Pressure figures and etch pits were made on both large crystals, and small embedded grains in this sample. $CuNH_4$ chloride was preferred to HNO_3 for this kind of etching. Measurements of the angle so obtained showed that the straight grain boundaries were parallel to traces of (112) planes. The structure is shown to be consistent with the fluorite type of twinning. The twins were probably true annealing twins, rather than unabsorbed grains, or remnants of twinned γ-Fe. Other work on this subject is reviewed and discussed. Single crystals of Fe produced by straining and annealing may contain internal twins, which may affect their tensile values. (*C. A.*)

Pickling of metals when using inhibitors. W. H. CREUTZFELDT. *Korrosion Metallschutz*, **4,** 102–107 (1928).—Weight loss measurements were made on annealed and oil-quenched steels varying in C (0.10 to 0.67%) in 5.3 *N* H_2SO_4 and in HCl. The attack increased qualitatively with the C content. Annealed, air-quenched and oil-quenched steels were exposed to 5.3 *N* H_2SO_4, the steels containing 0.10 C being attacked to the same extent, but at higher C concentrations the attack increased in the order of treating mentioned. Additions of salts of noble metals to the acid and of certain organic materials decreased the attack. Colloidal C effects no decrease and in some cases increases the attack. The inhibitors tested were useless with HNO_3. The effects on other metals were studied with the conclusions that: (1) the greatest decrease in attack occurred with Fe; (2) Ni, Al, and Sn were quite well protected; (3) no definite action could be established for Zn. Substances with free valences best lent themselves to use as inhibitors. The marked increase in activity of HCl on increasing temperature as compared to H_2SO_4 led to the conclusion that pickling should be done hot in H_2SO_4

and cold in HCl. The inhibiting phenomenon is explained by the formation of an insulating film on the metal surface. (*C. A.*)

Defects in soft, nonsilicon steels due to methods of production. K. VON KERPELY. *Mitt. staat. tech. Versuchsamtes (Wien)*, **16,** 108–17 (1928).—Defects are usually the result of using low-grade materials, although sometimes the rolling process introduces irregularities into the material. Failure is most often due to (1) nonmetallic inclusions which have their origin in the deoxidation process, (2) differences in grain size, (3) local coarsely crystalline areas, (4) oxide inclusions. Detailed directions are given for the production of boiler-tube steel. Since nonsiliceous steel has a greater tendency to release gases than siliceous steel, it is advisable to give the former a uniform preheating before rolling. The best rolling temperature is 1300°. Electric furnace steel is uniformly better than open-hearth steel for tubes, since a higher temperature is reached in its production. As a means of deoxidizing, ferro-C-titanium with Al is recommended. (*C. A.*)

Examination and properties of steel with physical peculiarities. F. STÄBLEIN. *Z. tech. Physik*, **9,** 145–47 (1928).—A short review is given, with curves, of the relations between the composition of steels and their magnetic qualities, thermal expansion, and specific resistance. (*C. A.*)

Danger to health of antimonial enamels. B. REWALD. *Z. angew. Chem.*, **41,** 287–88 (1928).—A criticism of the conclusions of Flury. Stress is laid on the innocuous character of sodium metantimonate and compounds of quinquivalent antimony generally. In a rejoinder Flury points out that compounds of quinquivalent antimony may be reduced in the actual process of manufacture of the enamel, and that enamels made from such compounds have in fact been shown to yield salts of tervalent antimony to acid solutions. (*B.C.A.*)

BOOK

Impurities in Metals: Influence on Structure and Properties. C. J. SMITHELLS. Chapman and Hall, Ltd., London, 1928. Price 18*s*. H.H.S.

Glass

Removing yellow or brown fusion edges from plate glass. ANON. *Ceram. Ind.*, **11** [2], 148 (1928).—The yellow or brown fusion edges on plate glass originate either from an unsuitable chemical composition of the glass or from unsatisfactory melting. The discoloring of the edges is increased through impure sand, old or damp soda, too little or too much alkali in the glass. If the effect originates from arsenic content, or if it is already solidly fired in through too much reduction, it cannot be removed; only lightly fired edges may be washed clean with slightly acidified water (an addition of 5% muriatic acid to H_2O). This defect may also be due either to the design of the blast burner or to a high sulphur content in the gas. It is difficult to determine which condition is the cause of the defect, for frequently they occur side by side. A wrong burner design usually results in a reduced flame. In this case small particles of carbon enter from the flame into the glass, that is, are dissolved by the glass. Depending on the degree to which the particles of carbon have entered the edge or brim of the pot, a washing off with nitric acid may be either useless or successful. If the gas has a high sulphur content, it should undergo an intensive cleaning before entering the burner. This may be done with a soda lye or by passing the gases through a scrubber. F.P.H.

Gravity flow process vs. suction feed process. III. B. M. PEARSON. *Ceram. Ind.*, **11** [2], 150–52 (1928).—Production of suction machine with plural mold is discussed, considering the case of the manufacture of medium and large size bottles on the machine. Bottle molds gradually get heavier and heavier for manufacturing the same class of ware. This has enabled a greater production to be obtained from the machine by reason

of the greater speed possible. The suction machines are generally operated at their highest possible speeds and some classes of the larger bottles, when taken off the machine, are not really set sufficiently well and require special handling such as placing the bottles on buck plates with push up to prevent the bottom collapsing before taking into the leers; in such cases the machine is being speeded up beyond the capacity possible with such ware today. In plural mold production, difficulties arise which are not easily explained. Because of the extra amount of heat contained in the larger weight of metal, the machine has to be slowed down and therefore, from the start, only half of the bottles are produced. Again, blowing two large bottles in the same mold is not at all the same thing as blowing one very large bottle, of twice the weight of the first-named bottle, blown in the same weight mold. Blowing a bottle depends upon even temperature distribution in the plastic parison. In the case of the suction machine, this uniform temperature distribution is dependent upon the efficiency of the cooling air on the molds. This cooling must be adjusted so that the mold is cooled evenly; with an uneven heat distribution in the mold, heat will be imparted quicker from the glass to the cooler portions of the mold than to the mold parts which have been cooled less. When this happens, the glass, being at an uneven temperature, blows up unevenly and the quality of the bottle suffers. F.P.H.

Uses of selenium. G. MALCOLM DYSON. *Chem. Age*, **18** [453], 17–19 (1928).—The principal use of selenium and its compounds is in the glass industry and for the production of ruby glazes in the ceramic industries. Its use in the glass industry is to remove the color from glass in which traces of iron are present. Almost any glass prepared from ordinary materials has a greenish tint, due to the iron present in it. It was at one time usual to correct this tint by the addition of manganese dioxide, but since the introduction of tank furnaces and of mechanical blowing and casting machines, it has been found that manganese is not successful in the presence of a reducing atmosphere. Selenium, however, decolorizes excellently under these conditions, and is added in the proportion of about $^1/_2$ oz. to 1000 lbs. of sand, together with $^1/_6$ to $^1/_3$ of its weight of cobalt oxide, to correct the slight muddiness which remains after selenium decolorization. It is not possible to correct the color of glass which contains more than one part of iron per 1000 lbs. since a muddiness develops. It has been found that sodium selenite is far more efficacious as a decolorizer than metallic selenium itself, even when allowance is made for the selenium lost by volatilization. If too much selenium is added a yellow or ruby color may develop. This phenomenon is made use of in the preparation of ruby glass. The "mix" for one such glass is made up thus: sand, 53.7%; potash, 15.25%; soda ash, 16.25%; zinc oxide, 11.37%; cadmium sulphate, 0.81%; selenium, 0.81%; borax, 0.81%. This mixture is charged in 30-lb. batches into a monkey pot, and treated by an elaborate series of heatings and coolings, which appear to be necessary for the development of the color. R.F.S.

Control and improvement of the composition of hollow ware. OSCAR KNAPP. *Glass Ind.*, **9** [8], 165–68 (1928).—Two methods to make best glass at the lowest cost are (1) the practical way, based upon several centuries of experience and on a collection of good rules and tried out glass batches, and (2) the scientific way, based on scientific knowledge, laws, and theories. During the past decades glass science has developed to the point where the control and improvement of glass batches can be effected through theoretical means without experimental melts. K. works out a new method, based on the theory that glass, while in the molten condition, is a true solution. As in solutions, the constituents of glass retain their properties, and it is therefore possible to calculate the properties of glasses from a knowledge of the properties of their components. The linear relationship between the glass forming substances and the properties makes possible the use of the graphical method. This method has the advantage that it allows one to

survey the whole field of all of the glasses from the standpoint of the property in question. It is shown how, by plotting glass properties and percentages of the glass-forming oxides in the form of equilateral triangles, it is possible to obtain a rapid view of certain glass compositions and to change them and improve them in any desired direction. A division of glasses into five groups, of which class I indicates very good glasses, and class V very poor glasses, is made according to some properties. This division is as follows:

Qualities	Class I	II	III	IV	V
Expansion	up to 50	50–75	75–100	100–125	over 125×10^{-7}
Density	up to 2.40	2.40–2.45	2.45–2.50	2.50–2.55	over 2.55
Elasticity	up to 5000	5000–6000	6000–7000	7000–8000	over 8000
Heat conductivity	over 205	200–205	195–200	190–195	up to 190×10^{-7}
Tensile strength	over 950	900–950	850–900	800–850	up to 800
Physical endurance	over 15	12–15	9–12	6–9	up to 6

E.J.V.

Glass lighting unit again in vogue. THEODORE LENCHNER. *Glass Ind.*, **9** [8], 180 (1928).—A survey of the National Lighting Equipment Exhibition at the convention of the Artistic Equipment Assn. held in Chicago, shows that there has been a gradual change in the thought of the public in regard to glass shades or units as a medium for diffusing the light from an electric lamp. For the past few years the frosted or colored ball lamp has been in vogue, without shading, or the glass shades have been replaced by such imitative material as silk, parchment, mica, etc. Two-thirds of the exhibits shown displayed the diffusion of light through glass units. The exhibit also brought out the facts that the lighting unit must not only be pleasing in appearance when lighted and unlighted, but that it should be free of glare, and that the lamp within the unit should be entirely concealed from view. Again the total light output of the unit should not be less than 40% of the total luminous output of the lamp within and could be as high as 70 or 75%. Further, the unit must be of such design as to provide a desirable distribution of light throughout the area on which it is to be used and that there are no objectionable streaks or shadows on the walls, ceiling, or floor. Glass, the natural material for the diffusion or shading of light, has come into its own and the present day manufacturer should further develop the use of glass units through the medium of artistically created shades, artistic both in shape and decorative design.

E.J.V.

Storage and packing of glassware. G. GEHLHOFF. *Glastech. Ber.*, **5** [5], 193–202 (1927).—The water film normally existing on a glass surface is not the main agent in the process of weathering. Its action is preparatory. The main agent of decomposition is water which condenses or falls on the glass surface. Alkali is dissolved out and converted into sodium carbonate by absorption of atmospheric carbon dioxide. Subsequent drying leaves residues of sodium carbonate, which being hygroscopic, form centers of attack and cause pitting. Alternate heating and cooling increases the speed of the weathering process, which is also accelerated by any influence assisting the absorption of moisture from the atmosphere, as wet packing material. Newly-made lead glass bulbs were covered with a film after only five days' storage in an open space, during moist autumn weather. The film on forty bulbs was washed off with hot distilled water. Calculating on the basis of the total weight of glass in the bulbs, the residue after drying the washings at 120°C was 0.0019%; the loss on ignition at 500°C of the dried sample was 0.0013%, and the nonvolatile residue was 0.0006%. This nonvolatile residue was analyzed and was found to contain: 21% SiO_2; 34% K_2O; 30% Na_2O; 15% CO_2, and some not determined. No lead oxide was found. The ratio of the soda content to the potash content in the glass was the most favorable, the amounts present being 8% K_2O and 7% Na_2O. Experiments were made with a Thuringian glass

of the composition 71.4 SiO_2; 2.9 Al_2O_3; 12.5 Na_2O; 7.6 K_2O; and 5.6 CaO. In these, the percentages of silica in the matter removed rose from 18.4% after three hours boiling to 36.6% after 12 hours. At the same time, the total alkali in the removed material dropped from 81.6 to 59.3%. Of the total amount removed in 12 hours, 62.3% was removed in the first 3 hours, whereas only 4.2% was removed in the last 3 hours. It was found that the suitability of the wrapping paper depended entirely on the degree to which it was hygroscopic. In tests carried out over a period of $1^1/_2$ years both lead glass bulbs and soda magnesia bulbs were better preserved when stored unwrapped than when stored in the most suitable paper. No difference was noted between the behavior of the two types of glass, the results depending entirely on the kind of paper used. The quality of the papers did not depend on the amounts of resinous size, ligneous fiber, aluminum sulphate, or sodium sulphate in the paper. Some of the papers caused bulbs to film in less than three months. The effects of carton packing were similar to those of paper wrapping, but to a less degree. No articles should be stored in paper for more than a year. Storage rooms should be dry, well ventilated, and heated in winter. Well-annealed glass resists attack much better than strained glass. Some evidence was obtained to support the theory that the "bluing" of lead glass, stored under moist conditions was due to reduction of lead compounds. Mechanically polished surfaces are less durable than fire polished surfaces. The poor durability of the internal surfaces of hollow ware, compared with the outer surfaces is not due to differences in the chemical composition resulting from fire polishing or to chilling. E.J.V.

Flow of glasses in tank melts. HANS JEBSEN-MARWEDEL. *Glastech. Ber.*, **5** [5], 202–12 (1927).—The establishment and operation of a tank furnace makes it evident that every systematic attempt to investigate the flow which takes place in every glass melt, and which depends on the movements due to thermal equalization, is connected up with a disturbance therein. An investigation led to the following conclusions: (1) The impulse to the circulation lies at the walls. (2) The motion of the glass mass is in principle that of two elastic cylinders whose vertical axes lie parallel to the furnace walls and are adapted to the lesser depth of the furnace, having an elliptical cross-section. (3) The intensity of the impelling force of the thermal rotation is manifested by the overcoming of the force of gravity on small bits of iron and by distinct lateral appearances of compression. (4) Combined with the flow underneath, which corresponds to the direction of flow of the glass, and the circular motion of the glass due to the tank having steeply sloping sides, there is the appearance that frequently there is not only one limiting layer, but generally two, placed one above the other. These limiting layers constitute the essential difference that fundamentally distinguishes the observations in the Pyrex tank which was cooled quickly from those in chilled glass, as it permits the conclusion that the concept of thermal disintegration is of considerable importance, not yet established accurately. The thermal circulation has the effect of retarding the homogenizing of the glass through selective working. Not all of the glass follows the direction of flow, but only an upper layer, the depth of which is shown to be a function of the cross-section and viscosity. In the idea of a homogenizing of the glass, the surface of contact of this flowing glass with the thermal currents must be given the greatest attention. It would be of some significance to be able to ascertain whether the thickness of the deposit of flowing glass, even in strongly acclaimed tanks, is less than in the furnace with smaller cross-section. This would be of significance on the single ground that in rapidly flowing glass the new analysis resulting is sooner adjusted than in sluggishly flowing glass. On the other hand radiation and conduction of the flame heat in the depths does not increase in combination with the working out but finds a limit where the upper layer, on account of slower flow, has no more time to combine with the lower, in regard to the exchange in heat and mass, where

the greatest efficiency of the furnace begins to be overreached. (5) The paths of flow of different sections of the molten glass are different, depending on the strata they are in. (6) The effect of thermal currents on corrosion is noticed. (7) A certain part of all sorts of manufacturing defects can be traced to thermal equalization movements. E.J.V.

Physico-chemical considerations of the melting process of simple glass mixes. H. F. KRAUSE AND W. WEYL. *Glastech. Ber.*, **5** [5], 213–17 (1927).—A report of observations made in a physico-chemical study of melts forming simple glasses, such as $CaCO_3$ and SiO_2; $(Alk)_2CO_3$ and SiO_2; and the systems K_2CO_3–SiO_2, and K_2O–CaO–SiO_2–CO_2. E.J.V.

Glass flow in the continuous tank. OTTO STUMM. *Glastech. Ber.*, **5** [6], 252–74 (1927).—A detailed account of an investigation of the flow of glass in a continuous tank. Ways and means used in making the investigation are outlined. The general scheme followed included a preliminary investigation, eight separate simple experiments, three series experiments, and twelve group experiments, all of which are discussed with the results obtained. E.J.V.

Experiments with different kinds of pollopas. C. PLONAIT. *Glastech. Ber.*, **5** [8], 354–60 (1927).—Pollopas is the "organic glass" discovered by F. Pollak and K. Ripper. It has a specific gravity of about 1.44, a hardness of 2 to 3 according to the Moh scale, is clear as glass, colorless, can be sawed, bored, turned, and polished. Tests were made on four kinds of pollopas, namely pollopas A, O, FF, and 6F, determining the water stability, drying stability, refraction of light, and permeability of ultra-violet rays. Pollopas 6F was found to be the best of those tested but it must be improved considerably before it can be really considered as a substitute for glass. E.J.V.

Measuring apparatus for testing the lighting properties of lighting glasses (illuminating glass tester). L. BLOCH. *Glastech. Ber.*, **5** [8], 360–66 (1927).—A description of an apparatus for making a direct comparison of the light permeability of an illuminating glass and some standard glass, one source of light being used to pass light rays through both glasses and the transmitted light rays being conveyed to the ocular by means of a system of prisms, lenses, and mirrors. E.J.V.

Investigation of the course of expansion by the passing of brittleness in viscous glass. A. KLEMM AND E. BERGER. *Glastech. Ber.*, **5** [9], 405–17 (1927).—A description of the furnace and auxiliary apparatus used to measure the expansion of the glasses is given. The actual measurements of the expansion were made with a microscope fitted with an ocular micrometer, one division of which corresponded to an expansion of 926×10^{-7} cm. Various types of expansion curves obtained are discussed and points in them representing cleavage points, transformation points, depression points, and inversion points are taken up. Curves showing the relationship of these points to the load, rate of heating, and thickness of the specimen, and of the expansion to the preliminary treatment of the specimen are presented and discussed. A series of lead borate glasses was investigated and relationships between their various properties and their compositions are pointed out. Further work of this nature is recommended. E.J.V.

Glass flow in a continuous tank. WALTER KONIG. *Glastech. Ber.*, **5** [9], 417–24 (1927).—The work of Otto Stumm (see STUMM abstract above) was completed from the experiences obtained in the works of the firm "Muhlig-Union" and simultaneously, the origin of the flow appearing in a glass tank was proved to be due to the temperature differences present in the tank, causing a lower return flow, which with the upper forward flow causes the circulation in the glass mass. E.J.V.

Gases in glass. H. SALMANG AND A. BECKER. *Glastech. Ber.*, **5** [11], 520–37 (1928).—The evolution of gases during melting of a clear glass, and during the refining of glass in industrial glass melting furnaces has heretofore been explained as being due to

the expulsion at high temperatures of gases, which are held dissolved in glass. In order to study this phenomenon, soda-lime glasses were tested with reference to their gas content, following a method developed for the extraction of gases from metals by scientists connected with the Institute of Metallurgy of the Technical University of Aachen. The apparatus was modified in such a way that a platinum crucible could be heated to 1400°C in a closed tube. The gases, which were removed by the use of a vacuum of 0.001 mm. mercury, were freed from moisture with phosphorus pentoxide, acid gases (carbon dioxide and sulphur dioxide) were removed with liquid air, and the oxygen was eliminated by combustion with pure hydrogen. The remaining gas was considered to be nitrogen. The increase in pressure after removal of the liquid air gave the volume of the acid gases, which were tested for SO_2 in the usual manner. The melting process could be observed directly, so that the slightest evolution of gas could be noticed. The results showed that even long continued heating at 1400°C did not suffice to remove all of the gas. It was found that an equilibrium is reached for each temperature, which can be upset by increasing the temperature, causing again a strong evolution of gas until a new equilibrium is established at the new temperature. From the escape of gas at 1400°C it could be concluded that the evolution would not be complete until extremely high temperatures had been reached. According to the temperatures of the experiments, the gases extracted from the glass had a volume measuring from one to two times the volume of the glass. They consisted of about three-fourths carbon dioxide, some oxygen, and some nitrogen, which were probably diffused into the apparatus from the surrounding air. A saltcake-lime glass acted differently from a soda-lime glass, inasmuch as the evolution of gas was much more energetic. The points of equilibrium at increasing temperatures were more sharply defined and the gases formed were principally sulphur dioxide and oxygen, in the proportion 1 SO_2 to $^1/_2\,O_2$. This proportionality of the gases and the formation of foam during their evolution can be explained as follows: The gases are probably not dissolved in the glass, but are formed during the heating under reduced pressure by decomposition of certain compounds, present in the glass, such as sodium and calcium carbonate, and sodium sulphate. The presence of the latter substance in sulphate glasses is probably due to the content of sulphur trioxide, which may be as high as 1%. Even at high temperatures and low pressures, and in the presence of an excess of silica, the sulphate compounds are not completely decomposed. This could be proved by experimental melts of salt cake and a salt cake and silica. The decomposition of sulphate yields sulphur trioxide, which under the conditions of the experiment must be decomposed into sulphur dioxide and oxygen. The increase in volume caused thereby tends to produce a strong formation of foam, which may, however, also be due to differences in the viscosity. The sodium oxide, formed by the decomposition of salt cake or soda ash probably combines at once with silica. The hypothesis that the gases are not dissolved in glass, but are present only as chemical compounds which are dissociated by heating, must be supported by experiments having the object to cause solution of gases in glass. To accomplish this, samples of soda-lime glass, previously completely freed from gas, were heated at temperatures ranging from 1000 to 4000°C under atmospheric pressure in the presence of carbon dioxide and nitrogen for several hours. They were then quickly brought into a high vacuum. In no case was there any evidence of the evolution of gas bubbles, so that the insolubility of gas in glasses may be considered as proved. Experiments with glasses of different composition and with other silicates are being continued. E.J.V.

Properties of the system soda-potash-lime-alumina silicate. E. BERGER. *Glastech. Ber.*, 5 [12], 569–97 (1928).—Glass science is primarily interested in the question as to which melts possess the least tendency to crystallize, or, to express it in positive terms,

which melts possess most prominently the properties belonging to the glassy state of matter. Science also desires to know the properties of these glasses. Experimental work on these problems carried on by various investigators is difficult to tabulate, since little has been done, and because the experiments have been conducted with different objects in view. This paper contains the results of systematic investigations of the system soda-potash-lime-alumina silicate, as part of the long series of experiments, made in the Jena Glass Works, Schott & Gen. The method of investigation is outlined, describing the type of furnace used, the melting process, the measurement of refraction, dispersion, density, expansion, durability, etc., and a study of the glassy properties. Photographs of a number of glassy, transparent stones, such as occur in fused boric acid, and also round transparent disks are included. The results of the investigation are shown in the form of curves, indicating the limits of the glassy, the semiglassy, and the completely crystalline states. Curves indicating similarity of properties are also given. The properties are represented in a four-dimensional diagram, showing that this mode of presentation has the advantage of greater economy and more precision. The results showed that in the system the refraction, density, and expansion are additive properties. The glassy property and the durability are not additive. Finally, the accuracy of the experimental work is discussed and the future field of investigation is outlined. E.J.V.

Stress phenomena in glass. F. RINNE. *Glastech. Ber.*, **6** [2], 65–76 (1928).—R. treats in a general manner the character of primary and secondary stress, which latter, as is known, is of extraordinarily great importance for the use and durability of glasses. In order to study stress in glass, for many years use has been made of the exceptionally fine method of observation in so-called linearly polarized light. In recent times this method has been developed more thoroughly. The polariscope gives an insight into condition of the stress that reduces the quality of the glass. A series of diagrams can be constructed, which characterize the existing conditions. For the easy comprehension of these conditions, R. includes the principle of linear-polarized light, with the aid of which a series of stresses, caused by impurities, thermal or mechanical effects, were illustrated and studied in detail. A demonstration of stress conditions on cutting glass is also taken up. An explanation of the compensation of stresses in glass, resulting from rather long heating (tempering) is given. With the aid of this method, the fracture of glass can be explained as an equalization of a stress, powerful enough to cause breakage. It is hoped that a more thorough insight into one of the most important phases of the glass industry will lead to further practical results. E.J.V.

Australian glass industry. ANON. *Chem. and Ind.*, **47**, 806 (1928).—The Australian Glass Manufacturers Co. made profits of £184,598 during 1927–28 as compared with £179,359 and £163,799 respectively in the two previous years. The capital investment is £1,105,478. H.H.S.

How glass is made. I. W. H. L. ANDERSON. *Crockery and Glass Jour.*, **106** [12], 22–23 (1928).—Methods used in making modern pottery are discussed nontechnically and except where necessity demands, the terms used in the manufacture are omitted unless fully explained. E.P.R.

Domestic production of window glass compared with competing foreign countries. ANON. *Nat. Glass Budget*, **44** [11], 3; [12], 3; [13], 3 (1928); *Glass Ind.*, **9** [8], 169–79 (1928).—Information obtained in the tariff commission's investigation is discussed and the processes and uses of window glass, hand-blown and machine-blown cylinder glass, and sheet glass are described. The Libby-Owens and the Fourcault processes are discussed. The installation of new Fourcault and Libby-Owen machines has caused an increase in the production of Belgian window glass. The organization of the Comptoir Fourcault and the elements of cost in the industry are discussed in considerable detail. E.P.R.

Electrolytic conductivity of glass with high field strengths. F. QUITTNER. *Akad. Wiss. Wien. Ber.*, **136** (2a) [3–4], 151–73 (1927); *Sci. Abs.*, **31,** 63 (1928).—The conductivity of the ordinary instrument glass and of Schott's glass 1447/III was investigated at temperatures from 20 to 52°C and with high strengths of field, with which the conductivity is actually raised. The conductivity was found to be purely electrolytic. It is proved by titration with 10^{-3} normal acid and iodine-eosin as indicator that Faraday's law holds for the multitude of metal ions wandering out from the glass in watery solution. Thus is made, depending on this method, a coulomb meter of great accuracy. By previous treatment with 10^{-2} normal K_2SO_4 solution as anode, a layer can be produced with Thuringian glass from which with reversal of the current no alkali wanders out. After long passage of the current in this direction the migration of Na increases so that the earlier condition of Na-migration can be almost completely attained. The percentage of the Na-ion-migration from Na_2SO_4 solution in glass 1447/III increases with rising concentration of the solution. From 1 normal Na_2SO_4 solution Na-ions migrate corresponding approximately quantitatively to Faraday's law. D.E.S.

Reflection from glass. P. AMY. *Rev. d'Optique*, **6,** 305–15 (1927); *Sci. Abs.*, **31,** 14 (1928).—A series of tests was carried out on various surfaces of glass, some of which had been recently polished and others not. A parallel beam of light was used, the light being reflected from the surface to be tested and then measured in photometer. Rayleigh's results on the change of the reflecting power produced by polishing were confirmed. The changes produced by chemical action, when glass was dipped into various solutions, were tested. The reflecting power was found to decrease to a minimum as the length of time in the solution was increased, but with further increase of time the reflection power increased again. Change of the temperature of the solution produced no effect. The maximum effect is obtained by using cleaned surfaces in a solution of ammonium sulphide diluted with an equal volume of distilled water. Fresnel's theory shows that the polarization is total for tan $i=n$, where i is the angle of incidence and n the index of refraction. Chemical treatment of the glass surface did not alter this relation. D.E.S.

Relative deformations of glass and fused silica under influence of temperature variations. A. ARNULF. *Rev. d'Optique*, **6,** 316–27 (1927); *Sci. Abs.*, **31,** 15 (1928).—Using an interference method tests were made on slabs of glass and fused silica, the slabs being 20 mm. in diameter, 9 mm. thick, and having plane parallel faces. Whether for reflection or refraction the silica has the advantage of a much smaller coefficient of dilatation than glass and a thermal conductivity nine times as great. The effects of heat on one face of the slab were tested to imitate the case of reflection, and of heat throughout the slab to imitate the case of refraction. In the former case the silica is deformed fifty times less than the glass. In the latter case, if steady states are reached, the two substances are practically equally affected, the variation of the refractive index being the predominant factor for silica and dilatation for glass. If temperature changes are rapid, silica is less affected on account of its greater conductivity. The objection to the silica is its lack of homogeneity and residue of birefringence and these are against its use for refraction, but it is of most importance for mirrors. D.E.S.

Internal friction of glass. P. P. LASAREFF. *Ceram. and Glass*, No. 1, 16–19 (1927). —Methods like those briefly described below may be used in this study: (1) The measurement of the rate of the fall of a metal ball in the molten glass. According to the well-known formula

$$V=\frac{2}{9}\,gr^2\,\frac{\sigma_1-\sigma_2}{\eta}$$

We may determine coefficient of the internal friction, η, if the velocity of the falling

ball V is known; r is radius of the ball, g, acceleration of force, σ_1 density of ball, and σ_2 density of liquid. (2) The measurement of angular deflection of a cylinder produced by a second (outer) coaxial rotating cylinder filled with a viscous liquid. This apparatus should be graduated by means of the liquid of known viscosity. For this purpose molasses may be successfully used. (3) The observation on motion of molten glass in the capillary tubes. In case of glass this method may be used at high temperatures only, when friction is small enough. Capillary tubes must be made of platinum. In case of glass the above-mentioned methods may be used at temperatures about 800 to 1000°C. The study of the internal friction caused a number of theoretical considerations of some empirical relations. Bachinsky was the first to suggest the formula connecting coefficient of internal friction η with specific volume, v.

$$\eta = \frac{c}{v-\omega}$$ where c and ω are constants.

In the case of glass this formula may be used within a certain range of temperatures, beyond which it is not correct. For higher temperature formula Le Chatelier is recommended: $\log \cdot \log \eta = A - Bt$ or better written as follows:

$$\log \cdot \log \cdot \eta = \frac{M(t-1000)}{1000} + N$$

M is negative; M and N may be expressed as a function of X representing the number of molecules of CaO present in the given glass, if general formula of it is as follows:

$3\ SiO_2 \times CaO(1-x)\ Na_2O$ in which case

$M_\alpha = 1.35 - 0.5x$; $\quad N_\alpha = 0.43 + 0.4x$

$M_\beta = 0.85 - 0.4x$; $\quad N_\beta = 0.50 + 0.25x$

where α and β show that given glass is stable at low and high temperatures respectively. Formulas of Bachinsky and Le Chatelier are practically identical through a large range of temperatures except high temperatures. A.I.K.

Solubility of glass constituents. W. MEYER. *Chem. Ztg.*, **52,** 151 (1928).—An ether-alcohol mixture after being kept in a glass vessel for 2 years was found to contain 0.001% of selenium as selenious acid; ethyl acetate, pure ether, methyl alcohol, amyl alcohol and amyl acetate were also found to have the power of dissolving selenious acid from glass. The selenium is derived from the selenium dioxide or sodium selenate used for decolorizing glasses containing iron. Jena glass gave no selenium after 12 months' test. (*B.C.A.*)

The weathering of glasses. II. K. TABATA, K. YEGAMI, AND S. MORIYASU. *Researches Electrotech. Lab., Tokyo,* **189,** 15 pp. (1927).—The samples were taken from melts of 1.0 R_2O, 0.5 BaO, y SiO_2; 1.0 R_2O, 0.75 BaO, y SiO_2; 1.0 R_2O, 0.5 CaO, y SiO_2; 1.0 R_2O, 0.8 CaO, y SiO_2 and 1.0 R_2O, 0.5 ZnO, y SiO_2. The results showed that all the glasses under experiment suffered weathering pretty much in the atmosphere. The crystals produced on the glass surface by weathering were alkali metadisilicate (with some water of crystallization). The results show that the alkali present in ordinary glass constitutes alkali metadisilicate. For Part I see *Ceram. Abs.*, **6** [6], 218 (1927). (*C. A.*)

The new glass factory of the Osram Company. GUSTAV SPENGLER. *Siemens Z.*, **8,** 57–61 (1928).—Illustrated. (*C. A.*)

The ring test for casing glasses. L. SPRINGER. *Sprechsaal,* **59,** 806 (1926).—S. was in agreement with the results of Gehlhoff and Thomas on the subject of the ring test (see *Sprechsaal,* **59,** 697 (1926); *Ceram. Abs.*, **6** [8], 335 (1927)) and quoted several earlier communications by various authors. Tests had proved that a colored casing made from the parent batch with large additions of coloring oxide (Fe and Mn) could

often be combined successfully with the parent crystal glass, even though its expansion coefficient was appreciably altered. Other properties, such as elasticity and relative thickness of the base and the casing glasses, also came into play. Casing glasses 1 and

	Cobalt Blue Glass 1	Cadmium Yellow Glass 2	Crystal Glass 3
SiO_2	45.7%	46.5%	77.15%
PbO	32.7	31.5	
Al_2O_3	0.5	0.5	
CaO	Trace	Trace	6.05
K_2O	9.0	9.8	10.05
Na_2O	Trace	Trace	6.75
B_2O_3	11.0	11.0	
CoO	About 0.5		
CdS		About 0.5	
Expansion coeff.	21.8×10^{-6}	21.9×10^{-6}	24.5×10^{-6}

2 in the table were used in conjunction with Bohemian crystal glass 3, although the calculated expansions were somewhat different. (*C. A.*)

The founding of the glass industry in Norway. P. R. Sollied. *Tids. Kemi Bergv.*, **7**, 97–100, 116–19, 129–32, 142–44 (1927).—Historical. (*C.A.*)

Hexagonal crystals found in devitrified glass. M. Bellière. *Ann. Soc. Géologique. Belg.*, **47** M 41 (1925).—Glass of the composition usually melted for hand-made sheet (approximately 71.6% SiO_2, 1.2% Al_2O_3, 14.6 % CaO, 11.6% Na_2O) is found to devitrify in a furnace let down for repairs, giving (1) spherolites of about 1 cm. diameter, and (2) groups of hexagonal plates several mm. long. The spherolites are obviously wollastonite ($CaSiO_3$), but between the larger fibers of wollastonite it is possible to detect, under a sufficiently high magnification, small dendrites. At first sight, the dendrites, being hexagonal, appear to be tridymite, but detailed examination shows that they have a high refractive index and strong birefringence (30–35). These properties suggest that they are pseudo-wollastonite, which, although it has the same composition as wollastonite, is optically and crystallographically quite different. The transition temperatures limiting the stability of the two crystal forms had previously been determined by Allen and White as 1180°, but at other temperatures they showed no tendency to change from one form to the other. Pseudo-wollastonite is produced in laboratory experiments and its properties are found to be exactly the same as those of the crystals formed accidentally in the tank of glass. (*J.S.G.T.*)

Crystals of wollastonite in devitrified glass. M. Bellière. *Ann. Soc. Géologique Belg.*, **50**, 285 (1927); *Glass*, **5**, 159 (1928).—Glass which percolates into the cavities beneath a furnace crystallizes very slowly and produces comparatively large, easily isolated, crystals of wollastonite. A crystal approximately 2 mm. long and 0.5 mm. across is sufficiently well formed to give satisfactory goniometer readings. Using the LaCroix notation, its angles were as follows:

	Calculated angle	Measured angle
p. o 3/2	29° 41′	29° 41′
p. o 1/2	50° 18′	51° 12′
p. h′	69° 48′	68° 47′
p. a 3/2	44° 38′	44° 21′

The crystal has at its end two inclined facets at an angle of about 44° to the direction of the length of the plate. The refractive index is 1.63 and the birefringence from 8 to 9. (*J.S.G.T.*)

Testing glass vessels for holding drugs, according to the specifications of the German Pharmacopoeia, 6th ed. L. Kroeber. *Apoth. Ztg.*, **41**, 1406 (1926); *Chem. Zentr.*,

[1], 785 (1927); *Chem. and Ind.*, **46,** 723b (1927).—A freshly-prepared solution of narcotine hydrochloride of 0.1% strength, filled into the vessel should show no sign of fine crystal formation for at least $^1/_2$ hour if the vessel is to be suitable for general purposes. No crystals should appear on 3 days' exposure in vessels suitable for the most stringent use. Glass suitable for use in the general storage of medicines should not discolor a solution containing 3 cc. of 0.1 *N*HCl and 5 drops of methyl-red per liter, on heating for $^1/_2$ hour on a water bath. (*J.S.G.T.*)

Improvement of rough cast plate and Fourcault glass by grinding and polishing. A. M. *Glashütte*, **57,** 1031 (1927).—A daily production of approximately 500 sq. m. of cast or drawn glass was treated by means of 2 grinding machines of table diameter of 6 m., and 4 polishing machines. For grinding and polishing, pure water was employed but the sand was elutriated only, without washing, a cheap batch sand being suitable. The grinding table used for the method of grinding glass upon glass was 3.5 m. in diameter, giving a total area of 16 sq. m. of glass, and consisted of a cast iron plate 12 mm. thick. The power required for rotation was 8 H.P. For grinding with iron tools, a table of 5.25 m. diameter was employed, the apparatus in this case consisting of two grinding tables. A horizontal transmission shaft was driven from a gearing by a belt, the shaft rotating the table by means of a conical wheel gearing. The grinding tool was movable from one table to the other so that progress was continuous, one table being set while grinding proceeded on the second. The total useful grinding surface available was 18 sq. m., and in 24 hours 8 settings, totalling 150 sq. m., could be treated. (*J.S.G.T.*)

Glassworks of the Osram Co. at Spandau. G. GEHLHOFF. *Glasindustrie*, **21,** 321 (1927).—In the new Osram factory, there is a main building housing the furnace with three bulb machines, and adjoining are the batch house, machine shop, and producer plant. Nearby are the laboratories and welfare institute, with baths, canteen, etc. The producer plant consists of two producers with rotating grates and adapted to use brown coal briquets. Various filters and purifiers are employed for the gas, thus rendering it fit for use on the cracking-off machines, etc. The furnace has a melting area of 5 x 6 m. and a working end of 3.5 x 5 m., with a total capacity of 130 tons (metric). Three ports are arranged on each side of the furnace. The molten glass is worked out by Westlake machines having an output of about 70,000 lamp bulbs per 24 hours. (*J.S.G.T.*)

The viscosity of glass. M. THOMAS. *Glasindustrie*, **21,** 327 (1927).—A summary of the recent work published on this subject dealing with the matter under four heads: (1) The purpose and significance of viscosity measurements, (2) viscosity measurements in low temperature ranges, (3) measurements at high temperatures, (4) suggestions for future measurements. (*J.S.G.T.*)

Glass skittle alley. ANON. *Glasindustrie*, **21,** 333 (1927).—In Halberstadt, the center of the German bowling sports, a skittle alley has been laid down in glass instead of wood or asphalt. The glass is opaque and laid in strips about 4 m. long, 35 cm. broad, and 30 mm. thick. The track covered is about 23.5 m. long, only approximately 815 sq. m. of glass being necessary for each alley way. Where the glass tracks have been laid, they are preferred to the older types. (*J.S.G.T.*)

Cassel crystal ware of about 1700 A.D. R. HALLO. *Glasindustrie*, **24,** 372 (1927). —A history is given of the members of the family who carried on the work of producing and decorating drinking vessels and artistic ware generally from rock crystal, beginning with the establishment of the workshop in the castle moat at Cassel in 1658 up to the end of the 18th Century. The most prominent member was Christopher Labhardt, 1641–1695, a number of whose works are described in detail from the art collector's point of view. (*J.S.G.T.*)

Automatic machine for production of ampoules. ANON. *Glas und Apparat*, **8**, 155 (1927).—A few particulars, but no working details are given, of an automatic ampoule-making machine to do the work of from eight to ten glass blowers. Tubing varying from 6.5 to 23 mm. in bore can be dealt with; the body length of the ampoule might range from 20 to 150 mm. while the narrowed ends might be from 30 to 220 mm. One type of machine produces double-ended ampoules, while a second divides these and seals the bases to make single-ended ones. Power consumption is about $^3/_4$ H.P. and air at about 3 lb. per sq. in. is needed. The over-all size of the machine is 120 x 75 cm., and its weight 270 kg. The machine is made in Germany, and having no heavy import duty it is hoped that it will enable manufacturers to compete in foreign markets, hitherto impossible on account of the high cost of the manufacture of ampoules. (*J.S.G.T.*)

History of Thuringian glasshouses (*continued*). F. PISCHEL. *Glas und Apparat*, **8**, 155, 167, 206, 215 (1927); **9**, 5 (1928).—The development of the glasshouses in Lauscha from the early part of the 17th Century is sketched, and extracts are quoted from ancient records to show the mode of life of the early workers. Particulars of some of the old leases are given. (*J.S.G.T.*)

Problems of the Russian glass industry. ANON. *Glas. u. Keram. Ind.*, **19** [6], 5 (1928).—During the year 1926–27 the production of window glass was 25,000 T. and of bottles 40,000 T. an increase in each case of some 28$^1/_2$% over the year 1925–26. Before the war, mechanically-equipped glassworks were rare, but in future only such works are to be erected. The first large mechanicalized glassworks erected since the Revolution was the "Dagestanskije Ogni" in Daghestan in the Caucasus, which was equipped with Fourcault machines. The lack of skilled technical men was the cause of heavy costs of production, owing to stoppages and to other causes, such as friction with foreign workmen. In some cases, the choice of the site for a factory was badly made, with consequent heavy transport charges for raw materials. Building costs also exceeded estimates by as much as 400% for one factory. At this factory, the production capacity of four machines was 20 million bottles a year; actually the production of 2 machines was only 1$^1/_2$ million bottles. The cost per bottle in April 1927 was eleven times higher than the estimate, while 60–70% of the production had to be rejected. During the next five years new factories are to be erected at a cost of 100 million rubles, in the following towns: Nishni Novgorod, Rostov, Poltorazk, Kiev, Lissitschansk, and one in Turkestan. Negotiations have been opened with German and American firms for the erection and equipment of these new factories. (*J.S.G.T.*)

The automobile headlight problem. L. B. W. JOLLEY. *Illum. Eng.*, **21**, 79 (1928).—Since the headlight problem affects both motorist and pedestrian, whose desires are to a certain extent antagonistic, a compromise is needed. To reach such a settlement three points needed deciding, namely, (1) the determination of a good driving light at a maximum specified speed, (2) the maximum illumination on the eye of (*a*) the pedestrian and (*b*) drivers of oncoming vehicles, which could be considered innocuous under road-traffic conditions, and (3) the design of a headlight to meet the requirements of (1) and (2). Since items (1) and (2) are not yet decided, it is not possible to solve (3) satisfactorily, but a start could be made by using a beam of standard divergence. The placing of a lamp filament in such a position as to obtain a beam of the desired divergence is discussed, and it is suggested that a start toward standardization should be made by fixing the details of the reflector design and that the standardization of lamp dimensions should follow. When agreement has been reached on these points, motor-car lamps should be rigidly fixed to car chassis, and no means of adjusting the position of the lamp should be provided.

The structure of lead as related to stained glass. S. L. BROWN. *Jour. Brit. Soc. Master Glass Painters*, **2**, 123 (1927–28).—There are three processes for making calm

lead: (1) casting, a process exclusively employed from the 10th to the 15th Century; (2) casting and drawing through a lead vice which came in about the 17th Century and was still extensively used in the United Kingdom, although very little in the U. S.; (3) extruding, or hydraulic process. The properties of the calms produced in these ways are compared and analyses are given of several specimens of ancient and modern leads. An alloy or material containing undesilverized lead plus $1^1/_2$ of tin is recommended as being best calculated to prevent the formation of lead carbonate. Attention should also be paid to the shape of the calms. (*J.S.G.T.*)

On Haber's glass cell. W. S. HUGHES. *Jour. Chem. Soc.*, p. 491 (1928).—Glass with low potash, alumina and borate content is found best for use in making Haber's cells, and should be blown as quickly as possible to avoid devitrification and heat-treatment effects on the conductivity and hydrogen-electrode function. The behavior of the cell can best be explained by the hypothesis that the hydrogen-ion concentration is maintained relatively constant within the glass phase by the buffer action of the sodium acid silicate in the glass. This action becomes less effective above a certain strength for alkaline solutions, and for solutions more alkaline than $p_H 13$ the glass surface is rapidly attacked. Sodium and lithium hydroxides show this effect more than potassium hydroxide, the probable explanation being that glass is more readily penetrated by sodium and lithium hydroxides than by potassium hydroxide, possibly because of the smaller dimensions of the ions. (*J.S.G.T.*)

A testing machine for glass rod and tubing. R. F. PROCTOR. *Jour. Sci. Instr.*, **4**, 465 (1927).—The routine testing of glass tubing or rod was carried out by measuring the maximum strain in the tube at the moment of fracture by bending. The interpretation of the results involved only the first power of the external diameter of the tube, whereas the results from a previous machine involved the fourth power and so demanded a very high accuracy of measurement of the tube or rod diameter. The expression for the breaking strain involved the dimensions of the machine and was stated to be $S = x_0 d_0/7467$, where x_0 is the distance to which the movable thrust pins are screwed down at the moment of fracture (the zero being the position when just in contact with the upper surface of the unloaded tube) and d_0 the external diameter of the tube in mm. Results of tests are given. The effect of annealing was investigated by taking samples, cutting each into four, annealing two of these, and testing as above. Fifty breaks of each were made, giving mean values of 0.97×10^{-3} for unannealed and 0.96×10^{-3} for annealed pieces. It was concluded that the strain present in tube, as drawn, would not cause appreciable error in the determination of breaking strain. (*J.S.G.T.*)

The sodium voltmeter. R. C. BURT. *Phys. Rev.*, **27** [11], 813 (1926).—A modification of this voltmeter, using the electrolysis of sodium through glass, has been made by using metal contact with the glass instead of thermionic emission. This voltmeter possesses a large advantage over the silver voltmeter under ordinary working conditions and yields results certainly correct to 1 part in 2000 parts, and probably to 1 part in 6000 parts. (*J.S.G.T.*)

Electrolytic conduction of potassium through glass. V. ZWORYKIN. *Phys. Rev.*, **27** [11], 813 (1926).—By connecting the filament of a thermionic vacuum tube to the negative terminal of a direct current supply, while the positive terminal was connected to a crucible containing molten potassium nitrate in which the tube is immersed, Z. succeeded in passing sodium into the tube, while the glass itself was enriched in potassium at the expense of sodium and became unusually brittle. When a potash glass, free from sodium, was used, potassium of high purity passed into the tube without corroding the glass or rendering it brittle. This appeared to show that the failure of Burt's attempt to pass potassium through a soda-potash glass was due to the difference in dimensions and molecular forces of potassium and sodium ions. (*J.S.G.T.*)

BOOK

Die Glasätzerei. J. B. MILLER. 5th ed., revised. Vol. 59 of chemisch-techn. Bibliothek. Vienna: A. Hartleben. 132 pp. M. 3; bound in half linen, M. 4. (*C. A.*)

PATENTS

Continuous process for making sheet glass. G. E. HOWARD. U. S. 1,616,371, Feb. 1, 1927. Relates to the method of making sheet glass continuously in which the sheet is drawn vertically upwards from a bath of molten glass, or through a wide spout. It is found in some cases that the sheet tends to curve slightly in a transverse direction and it is necessary to pass it while still plastic over a flattening roller. The invention consists in providing devices which grip the edges of the sheet and stretch it laterally. The sheet is thus flattened without making contact with any rollers or tables, and its surfaces cannot be marred. The construction of the gripping device is described fully in the specification. (*J.S.G.T.*)

Method of regulating the charge from feeding devices. G. E. HOWARD. U. S. 1,619,729, March 1, 1927. A method of regulating the weight of the charges of glass delivered by a feeder consists in periodically weighing one of the articles formed from the charges, and varying the rate at which the glass is delivered by the feeder in automatic response to the variation of the article from a predetermined range of weight. The construction of suitable apparatus for carrying out the method is described and illustrated in the specification. (*J.S.G.T.*)

A mold for pressing fruit juice extractors. W. M. BRISTOL. U. S. 1,627,884, May 1, 1927. The invention relates to a method of making the glass extractors for use with oranges and like fruit, which consists of a dish-like receptacle having a central conical boss which is ribbed or corrugated. It is the object of the invention to make extractors of which the corrugations on the boss have sharp edges. The mold consists of body portions hinged on a base, and a plug which has a conical top. This plug is carried by a collar which screws into the base, and can be turned by a handle so as to raise or lower the plug. It will be seen that the article is pressed in an upright position. In use, a ball of glass is placed on the top of the plug, and the descent of the plunger forces the glass down around the conical top of the plug into the molding space. As soon as the article is formed, the handle, is turned to lower the plug, thus allowing the boss of the article to contract as the glass chills and so prevents breakage. By placing a ball of glass on top of the plug, the boss of the article is formed while the glass is hottest and the corrugations are formed with sharp edges. (*J.S.G.T.*)

Mold-charge guiding device. KARL E. PEILER. U. S. 1,629,926, May 24, 1927. In combination with a glass shaping mold, a guiding member adapted to be projected into the mold cavity in spaced relation with the walls and bottom thereof to deposit a mold charge in the bottom of the cavity and prevent contact between the charge and the upper wall of the mold.

Ware transferring mechanism. EDWARD H. LORENZ. U. S. 1,642,421, Sept. 13, 1927. (1) The combination with a ware shaping machine, of means for delivering glass to the machine, and ware transferring mechanism embodying pneumatic means for discontinuing the operation of the shaping machine and the operation of the delivering means. (2) The combination with a glass shaping machine embodying a mold element, of a ware transferring mechanism provided with a ware engaging device, means for swinging the device toward and away from the mold, and means for projecting and retracting the device radially, with respect to the axis of swinging movement, to and from a position above the mold.

Changing glass-feeder bushings. JOHN MURL LENTS. U. S. 1,642,881, Sept. 20, 1927. The method of temporarily obstructing the flow of molten glass through a channel or passageway at a predetermined point and permitting the glass beyond the point

to be withdrawn, which comprises placing a mechanical obstruction across the path of the glass at that point, agitating the obstruction to prevent freezing of the obstruction to the walls of the channel, and removing from the channel the glass beyond the obstruction.

Glass drawing apparatus. ARTHUR E. SPINASSE. U. S. 1,643,184, Sept. 20, 1927. In glass drawing apparatus, drawing means for drawing and preserving the alignment of the sheet, and auxiliary rolls in addition to the drawing means yieldably pressed against opposite sides of the sheet and positioned to divert falling particles of the glass sheet.

Pouring apparatus for glass furnaces. DANIEL S. BEEBE. U. S. 1,643,601, Sept. 27, 1927. A glass furnace chamber having a discharge passage through which molten glass is adapted to flow by gravity, a valve slidable across the outlet end of the passage, and means carried by the valve for pushing the glass remaining in the passage when the valve is closed back into the furnace chamber.

Feeding molten glass. KARL E. PEILER. U. S. 1,644,893, Oct. 11, 1927. In heating the discharge chamber of a glass feeder having parallel side walls, a curved portion connecting the side walls and a vertical flow-controlling implement forming a heat obstruction in the forward portion of the chamber, the method that comprises projecting a heating flame forward and downwardly along a side wall of the chamber and to one side of the obstruction, circulating the flame around the forward portion of the obstruction and the curved walls and causing the flame to return to the rear of the chamber in contact with the glass.

Leer conveyer. PERCY Q. WILLIAMS. U. S. 1,646,047, Oct. 18, 1927. In a device of the class described the combination of a conveyer for bottles to be rolled on their sides, of a series of nozzles to direct blasts of air transversely of the conveyer, adjacent nozzles directing the air blasts in opposite directions whereby the air blasts may cool and roll the bottles.

Reënforced glass. MICHAEL LIPTAK. U. S. 1,646,097, Oct. 18, 1927. A section of transparent material having parallel striplike reënforced and unreënforced portions forming alternating striplike areas.

Gathering-pool level regulator. KARL E. PEILER. U. S. 1,646,705, Oct. 25, 1927. The combination, with a glass melting tank having a discharge outlet, of a container arranged to receive molten glass from the melting tank and vertically movable with respect thereto, a gate for regulating the discharge of glass from the tank to the container, a pivotally mounted support for the container, a counterweight carried by the support for counterbalancing the weight of the container and its normal contents of glass, a connection between the support and the gate for raising the gate when the container rises and for lowering the gate when the container descends, and springs above and below the pivoted support for retarding the vertical movements of the support and of the container.

An improved mirror. J. L. DRAKE. U. S. 1,653,040, Dec. 20, 1927. A mirror is made of laminated glass in order that it will not shatter when broken. The laminated glass may be made by any known process by which two sheets of glass with an intermediate, nonbrittle layer of cellulose composition are secured together to form a compound sheet. According to the invention, the nonbrittle layer is silvered before it is united to the glass sheets. (*J.S.G.T.*)

Glass teeming apparatus. HARVEY H. DEULEY. U. S. 1,677,275, July 17, 1928. Apparatus for the delivery of molten glass in a succession of unit charges including a ladle pivoted on a horizontal axis asymmetrical in shape with respect to a vertical plane passing through its pivotal axis, its center of gravity when empty lying on one side of such vertical plane and its center of gravity when filled with molten glass lying on the other side of such vertical plane.

Glass feeding and delivering mechanism and process. ENOCH T. FERNGREN. U. S. 1,677,436, July 17, 1928. In apparatus for separating charges of molten glass, a container having a discharge outlet, a charge shaping transfer cup adapted to form a pneumatic working connection with the outlet, means for producing an abnormal pressure in the cup when in charge-receiving position at the outlet, means for supporting the cup and for oscillating the same laterally toward and away from the outlet, and mechanically operated shears arranged to meet between the cup and the outlet to sever the glass in timed relation with the movement of the cup.

Sheet-glass-producing apparatus. JOHN L. DRAKE. U. S. 1,678,060, July 24, 1928. In sheet glass apparatus, means for drawing a sheet upwardly from a mass of molten glass, and a flattening member for the sheet arranged after the drawing means, the peripheral speed of the drawing means being relatively slower than the peripheral speed of the flattening member.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,678,232, July 24, 1928. (1) A glass feeder comprising in combination a container for molten glass having an outlet in its bottom, an inclined stirring rod projecting downward into the glass above the outlet, and means to rotate the rod. (2) The combination of a container for molten glass having an outlet opening in the bottom thereof, a regulating plug extending downward into the glass over the outlet, means to periodically reciprocate the plug vertically, inclined stirring rods projecting downward into the glass at opposite sides of the plug and formed at their lower ends with stirring heads dipping into the glass, and automatic means for continuously rotating the stirring rods about their own axes.

Glass forming machine. LEONARD D. SOUBIER. U. S. 1,678,233, July 24, 1928. (1) A glass forming machine comprising in combination, a rotary mold carriage, a mold thereon open at its upper end to recive a charge of glass, a guide for directing the charge into the mold, a carrier for the guide, mounted on the mold carriage and means to oscillate the carrier about a nonvertical axis and thereby alternately lift and lower the guide out of and into a position over and in register with the mold. (2) A glass forming machine comprising in combination, a rotating mold carriage, a mold thereon, a shaft mounted on the carriage with its axis inclined to the axis of the mold carriage, a guide mounted on the shaft for directing charges of glass into the mold, and means controlled by the movement of the carriage to revolve the guide about the axis of the shaft into and out of charge guiding position over the mold.

Glassware annealing leer. LEONARD D. SOUBIER. U. S. 1,678,234, July 24, 1928. A heating unit comprising sets of transversely spaced tubes, electric heating elements individual to the tubes, means to supply electric current to the heating elements, current flow regulators individual to each transverse set of tubes, and means whereby adjustment of each regulator functions to vary the number of effective heating elements in each transverse set.

Method and means for feeding and shaping molten glass. ENOCH T. FERNGREN. U. S. 1,678,247, July 24, 1928. (1) The combination with a container for molten glass having an outlet opening in the bottom thereof, means to supply molten glass to the container at one side of the outlet, a baffle extending into the glass, means to rotate the baffle and thereby shift the path of flow of the glass to the outlet, and means to periodically vary the speed of rotation of the baffle. (2) The method of keeping the glass which is circumlocal to a glass releasing outlet, in a state of like mobility, consisting in constantly changing at a periodically varying rate of speed, the path of movement of a major portion of a stream of glass flowing to the outlet, and correspondingly changing the path of movement of a minor portion of the stream of glass.

Method and apparatus for feeding molten glass. GEORGE E. HOWARD. U. S. 1,678,291, July 24, 1928. (1) Apparatus for producing mold charges of molten glass

comprising a container for the glass having a discharge outlet and a rotatable flow-controlling member disposed in line with the outlet, the flow-controlling member having a corrugated surface immersed in the glass. (2) In glass feeding apparatus, two coöperative flow regulating members, one comprising a container for molten glass having a submerged discharge aperture and the other comprising an implement extending into the glass substantially in axial alignment with the aperture, one flow regulating member having nonspiral projections extending into the glass around the axial line of the outlet, and means for rotating one flow regulating member about the axial line of the outlet.

Bridge wall for glass tanks. ALFRED W. DODGE. U. S. 1,679,295, July 24, 1928. A bridge wall for glass tanks, having a trough in the interior thereof, the side walls and bottom formed of the refractory material of the bridge wall, and means for circulating cooling water in the trough in contact with the refractory material.

Sand-blasting apparatus. CHARLES F. MOTZ. U. S. 1,679,369, Aug. 7, 1928. Glass-cutting apparatus, comprising a blast nozzle, a driving shaft, a cam mounted thereon for moving the nozzle, a second shaft, a pinion mounted on the 1st-named shaft, a gear wheel loosely mounted on the 2nd shaft and meshing with the pinion, a cam member mounted on the 2nd-named shaft and operable to maintain driving engagement between the gear wheel and the 2nd-named shaft during only a single revolution thereof, a second cam member on the shaft, an air supply valve for the nozzle, a connection between the last-named cam and valve, whereby the valve is closed upon completion of each revolution of the gear wheel, and means independent of the 1st-named shaft for imparting movement to the 2nd shaft to cause one of the cam members carried thereby to effect driving connection between the gear wheel and its shaft and cause the other cam to permit opening of the valve.

Crackled ware and semifinished blank therefor. DAVID L. MIDDENDORF. U. S. 1,679,437, Aug. 7, 1928. An article of finished glassware having crackles therein in the form of round-bottom furrows.

Bottle-making machine. SYDNEY L. SEARS. U. S. 1,679,502, Aug. 7, 1928. In a machine for making molded articles, a frame having a track composed of a main portion in the form of a convex arc of a circle, and another portion, in the form of a concave arc of a circle, connecting the ends of the main portion, a carriage having means to engage the track and to travel along the same, mold portions connected with the carriage and adapted to pass substantially in registry with the center of the concave arc, and means for moving the carriage and for completing the formation of a molded article during the travel of the carriage.

Glass press. WILLIAM T. BARKER, JR. U. S. 1,679,848, Aug. 7, 1928. In combination with a glass feeder having a feeding outlet, a glass pressing machine having a mold mounted for movement beneath the outlet and into vertical alignment therewith to receive a mold charge delivered therefrom, and a pressing plunger mounted for movement into alignment with the outlet and the mold for pressing the mold charge while the mold is in its charge-receiving position.

Sheet-glass-protecting means and method. LEOPOLD MAMBOURG. U. S. 1,680,227, Aug. 7, 1928. In sheet glass apparatus, means for drawing a sheet from a mass of molten glass, and means for spraying a protective film upon the sheet or parts of the glass apparatus with which the sheet contacts.

Sheet-glass-drawing apparatus. LEWIS D. BLACKSHERE. U. S. 1,680,240, Aug. 7, 1928. The combination with an endless sheet glass drawing apparatus draw table, and means for heating the same, of means for protecting the sheet carrying run of the table from the heating means.

Sheet-glass apparatus. JAMES C. BLAIR. U. S. 1,680,241, Aug. 7, 1928. In sheet glass apparatus, a receptacle containing a mass of molten glass, a slab associated

with the receptacle, means for flowing a relatively thick sheet of glass down the slab, and a pair of rolls arranged at the end of the slab for reducing the sheet in thickness, and means for moving the slab and rolls simultaneously.

Grinding and polishing glass, marble, etc. L. REMBAUX. Brit. 284,271, March 21, 1928. A machine for grinding or polishing plates of glass, marble, etc., consists of a frame carrying a table which may be moved continuously or reciprocated, and has mounted thereon a carrier for the glass. Supported above the table on columns is a frame carrying a series of grinding units each of which consists of a cylinder having rotatably mounted therein a hollow shaft carrying a plate in an eccentric sleeve on which is slidably mounted a shaft. The shaft carries the grinding disk and a pinion engaging an internally toothed wheel; an intermediate pinion also may be employed between the pinion and the wheel. The shaft is lifted or lowered by an arm connected to a piston movable in a cylinder by compressed air supplied through a pipe and vertical movements of the shaft are cushioned by a dash-pot. The glass carrying table may make two strokes, one a working stroke, and the other to enable the carrier to be removed. The shafts are driven by a chain from an electric motor mounted on the frame.

Grinding lenses. A. BUTLER. Brit. 286,118, April 25, 1928. In a machine for grinding cylindrical lenses, the lens is supported on a holder which is moved by an eccentric pin on a rotating shaft, and the tool is carried on a holder mounted on an arm having therein holes whereby the arm may be pivoted by a pin to swing about an axis either above or below the tool, in order to grind a positive curve or a negative curve on the lens. The pin may be inserted in any of three sets of holes in a part of the machine frame and in a spaced plate and the arm is rocked about the pin by a link engaging a pin on the arm and moved by an eccentric pin on a rotating shaft. The pins have grooves therein for engagement with latches, whereby they are held in the operative or inoperative position.

Glass threads. CHEMISCHE FABRIK STOCKERAU AND F. POLLAK. Brit. 288,978, June 13, 1928. In making glass threads, the heating which is necessary for fusing the glass is effected by means of electric resistance heaters. The glass may be prepared from cullet which is melted in a pot by means of electric resistance heaters arranged either inside or outside of the pot. When completely fused, the glass is discharged from the pot through nozzles which may also be heated electrically. If the threads are drawn from glass bars or rods, the rods are passed between or past electric heating members to soften the glass.

Glass manufacture. R. F. HALL. Brit. 290,685, July 11, 1928. Relates to a forming machine of the kind which comprises a frame movable with respect to a fixed element, and in which a bracket or the like, carrying a mold and pivoted to the frame, is moved by a cam on the fixed element.

Metal in glass manufacture. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY ET CIREY. Brit. 291,468, July 25, 1928. Relates to glass which has a considerable degree of transparency to ultra-violet rays, and to the tendency of the glass to lose a considerable part of its transparency. In order to correct this tendency, a small proportion of oxide of manganese is incorporated with the glass. Silica glass and transparent cast silica may be treated similarly.

Sealing the flared pinch in the lamp bulbs. PATENT-TREUHAND GES. F. ELEKTRISCHE GLÜHLAMPEN, M.B.H. Ger. 452,652, May 8, 1924. In the process of sealing the flared pinch on to the base of lamp bulbs by rotating under a sealing flame, a bulb blank only a little longer than the overall length of the finished lamp is gripped at its lower edge by mechanically actuated tongs, which bring it, after exposure to the sealing flame, up to the flare of the pinch and draw off the excess glass when the seal is completed. *(J.S.G.T.)*

Process for blowing double-walled vessels. GLASFABRIK SOPHIENHÜTTE R. BOCK G.M.B.H. Ger. 452,713, May 23, 1925. (Addition to Ger. 349,862.) In the process for blowing double-walled hollow-ware according to the original patent and additions, (Ger. 375,339, and 401,592), the inner surface was produced by first blowing out the wall at the desired point, inverting, and filling the hollow so produced with the amount of molten glass necessary to form the inner wall. (*J.S.G.T.*)

Apparatus for drawing quartz rod or tube. ALLGEMEINE ELEKTRICITÄTS GES. Ger. 452,938, March 10, 1925. A cylindrical furnace for fusing quartz, with a resistor heater disposed axially along the body, was provided with a tube leading from outside to the lower part of the fusing zone through which, by insertion of suitable drawing rods, or the like, the fused quartz could be drawn out into tube or cane. (*J.S.G.T.*)

Continuously rolling sheet glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY ET CIREY. Ger. 453,258, Oct. 17, 1924. In a process for the above in which glass flows from an aperture below the level of the glass in the tank, and passes between two rollers placed against the aperture, the latter is so disposed that its level comes below the aperture between the rollers to ensure that the glass only makes contact with the lower roller until immediately within the roller aperture. (*J.S.G.T.*)

Conveyers for electric lamp bulbs. PATENT-TREUHAND GES. F. ELEKTRISCHE GLÜHLAMPEN, M.B.H. Ger. 453,696, Sept. 10, 1925. A double conveyer belt, holding the bulb, neck down, in the middle, places it in a compartment in a rotating disk, and the latter then delivers it to another machine for further process work. (*J.S.G.T.*)

Drawing out and reducing walls of lamp bulbs. PATENT-TREUHAND GES. F. ELEKTRISCHE GLÜHLAMPEN, M.B.H. Ger. 453,885, May 29, 1925. Means are disclosed whereby the neck wall of the bulb could be drawn out and thinned preparatory to fixing in the pinch. (*J.S.G.T.*)

Continuous production of rolled sheet glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY ET CIREY. Ger. 454,389, Oct. 18, 1924. Canal-shaped ducts heated by gaseous fuel formed the mouth feeding the rolls in the production of rolled plate, and were adjustable so as to partially or completely close the tank mouth, if necessary. (*J.S.G.T.*)

Self-acting feed to pinch sealing machine. PATENT-TREUHAND GES. F. ELEKTRISCHE GLÜHLAMPEN, M.B.H. Ger. 454,423, Sept. 29, 1926. Bulbs were fed by one endless band on to another, moving perpendicularly to it and displaced one step forward after each row of bulbs had been placed on it. (*J.S.G.T.*)

Cutting elliptical shapes in glass. K. NODA. Ger. 454,429, Aug. 16, 1925. In a machine for cutting elliptical shapes in which the cutter moved to and fro on an axis, the said cutter was fastened to the end of an arm revolving in a circle, and was given a to and fro movement along the arm so that the resultant curve was an ellipse. (*J.S.G.T.*)

Production of glass opaque to X-rays and rays of short wave-length. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY ET CIREY. Ger. 454,430, Jan. 12, 1927. The glass has a high lead oxide or lead oxide and barium oxide content, and up to 10% of the silica content could be replaced by zirconia. (*J.S.G.T.*)

Extrusion of molten glass from a tap hole. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 454,537, Nov. 13, 1926. A plunger forced out the glass by a reciprocating movement, it having also a rotational motion. The plunger worked in a sleeve having ribs or corrugations longitudinally. (*J.S.G.T.*)

Step-by-step rotating cap sealing machine for electric lamp bulbs. PATENT-TREUHAND GES. F. ELECTRISCHE GLÜHLAMPEN, M.B.H. Ger. 454,566, Oct. 25, 1925. Rota-

tion of the machine brings the bulb in turn into positions for heating the cap, cutting off the excess of the internal leads, soldering the same to the cap, cooling off, and finally into contact with leads for fixing the "getter" or "clean up" material. (*J.S.G.T.*)

Continuously drawing sheet glass. J. HANAPPE. Ger. 454,643, April 1, 1921. In a process for drawing sheet glass from the forehearth of a tank, provision was made for heating the surface of the glass at the drawing point. (*J.S.G.T.*)

Process and apparatus for the production of sheet glass by rolling and annealing. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOIT. VAN DETROVIEN. Ger. 454,711, May 5, 1925. Means are provided for equalizing the temperature of the rolled sheet during the time elapsing between the entry of the first and last portions into the leer. (*J.S.G.T.*)

Working of sheet glass. PILKINGTON BROS. Ger. 454,788, Nov. 5, 1924. The invention relates to the layout of track and the journey of the cars in a continuous grinding and polishing shop. (*J.S.G.T.*)

Feeding glass forming machines. VITREA A. G. Ger. 454,828, Nov. 28, 1926. In a feeding device where a gathering was sucked up into the mold, a knife was arranged to cut off the gathering on the underside of the mold. (*J.S.G.T.*)

Producing reinforced plate glass. E. DANNER. Ger. 454,829, June 21, 1925. The reinforcing material was fed vertically downward through an orifice in the boot of a glass tank and on either side of it sheet glass was drawn, the three being incorporated by rolls to produce one composite sheet. (*J.S.G.T.*)

Machine for polishing parallel surfaces. W. H. OUBRIDGE. Ger. 454,844, Aug. 28, 1925. In a machine for polishing the ends of rings, in which the rings were disposed in a cage between grinding disks, the radius of displacement of the cage was made adjustable so that the stroke of the cage motion suited the diameter of the work. (*J.S.G.T.*)

Apparatus for continuous production of tube and cane. GLASWERKE RUHR A. G. Ger. 454,877, May 23, 1924. The rotary distributor member from which the glass flowed, was made of metal or other material resistant to molten glass and was adapted to be cooled so that it was further protected by a layer of chilled glass in use. (*J.S.G.T.*)

Grinding and polishing edges of clock glasses and the like. W. ZIEROL. Ger. 454,939, April 17, 1925. Grinding and polishing disks were disposed to work on the edge of the glasses mounted on a rotating head. (*J.S.G.T.*)

Heavy Clay Products

Cause and prevention of kiln and dry-house scum and of efflorescence on face brick walls. L. A. PALMER. Bur. Stand., *Tech. Paper*, No. 370, 50 pp. (1928).—To determine the sources of efflorescence, 288 "wallettes" were constructed of 32 different types of face brick, together with 4 types each of limes, Portland cements, and bricklayers' cements. Continuous tests extending over a period of 6 months were made with the wallettes and simultaneously with the brick. Seventeen types of face brick developing no efflorescence in individual tests on brick alone did develop such in the wallettes. The use of waterproofing compounds in mortar is discussed. A number of tests indicates that the stearates are the most effective of such waterproofing materials. Efflorescence on facebrick walls may be due to soluble salts in cement, lime, or concrete materials wherever used in a wall, to common brick and hollow tile in the back-up materials, and to the harder fired face brick. Many face brick, as well as mortar materials, contain a negligible amount of such soluble salts and are safe from the standpoint of efflorescence. If a brick contains 0.05% or less of water-soluble sulphuric anhydride in its outer $^1/_8$ inch of exposed surface, it is not apt to contribute to the development of efflorescence

on a wall under conditions most favorable for such development. Such salts in the mortar materials which tend to appear on a wall surface under favorable conditions may be prevented from so appearing to a very considerable extent by the use of certain water-repellent substances. These substances should be well mixed with the mortar materials. The most effective of such water repellent substances have been found to be ammonium or calcium stearates. Either of these material should be added to mortars in an amount equal to 2% by weight of the cement or lime, or of the cement plus lime in case both are used in the mortar. Salts in brick which may contribute to the development of efflorescence on a wall are for the most part formed in the surfaces of the brick during the drying and firing operations. The salts so formed in the surface of face brick are also the cause of kiln scum. In order to reduce kiln scumming and any tendency in a face brick to develop efflorescence when laid in a wall, intelligent control of plant procedures is far more necessary and is also far more economical means than is the use of barium compounds. In order to reduce the extent of formation of sulphates in the drier, every controllable factor should be so adjusted as to insure the maximum rate of drying, at the same time keeping within the limits of safety in regard to cracking. The most desirable conditions to insure rapid drying, and hence a minimum of salts formed in the brick during this operation, are: (*a*) low humidity, (*b*) a minimum amount of mixing water, (*c*) a relatively high temperature (212°F, if possible) and (*d*) good circulation of air or draft in all portions of the drying chamber. The ideal condition is to admit none of the gaseous combustion products of sulphur into the drying chamber. This condition may be approached, if not actually realized, by exhausting the kiln for a period of time before connecting it to the drier if the waste-heat system of drying is used. It is necessary also to thoroughly rake out and clean all fire boxes before connecting a kiln to a drier. By observing this point an annoying instance of scumming has been thoroughly checked in one plant after it had continued for a period of 2 months. The period of watersmoking should be shortened to the least possible length of time. A good draft will make such a method of procedure a safer one. Increasing the draft is not as effective for rapid drying as increasing the heating rate. If there is an appreciable quantity of pyrite in the clay, the extent of soluble salt formation is increased by a rapid draft at the combustion temperature of pyrite. It is hardly within the realm of possibility to decrease materially the extent of sulphate formation by attempting to find a coal low in sulphur content. Under favorable conditions for the formation of salts, decreasing the concentration of sulphur dioxide from 5 to 0.5% by volume of the total kiln atmosphere accomplishes but very little. If in order to produce a desired shade of face brick it is impossible to fire with a reducing atmosphere, the soaking period should be extended. The soaking temperature should be increased as much as possible without altering the desired shade. It is probable that reduction carried out at a temperature of from 1600 to 1750°C may effect practically complete decomposition of the sulphates, and that by thereafter changing to an oxidizing atmosphere and continuing such during the entire soaking period the desired shade may be acquired and a brick free from scum and with no efflorescence-forming sulphates in it may be produced. Dry-house or fixed scum is caused by soluble salts in clay. These salts are for the most part sulphates of sodium and potassium which melt before decomposition is effected. They accumulate on the surface during slow drying and melt (become "fixed") during subsequent firing. Dry-house scum may be reduced if not altogether eliminated by (*a*) rapid drying, (*b*) a strongly reducing atmosphere maintained at a temperature of from 1600 to 1700°F (too low for these salts to melt) and (*c*) barium treatment of the clay. Barium compounds are recommended when and only when dry-house or fixed scum is known to occur. It is further recommended that for this purpose the more soluble compounds of barium rather than barium carbonate be used. R.A.H.

New equipment. J. A. DEMAREST. *Brick Clay Rec.*, **73** [2], 94–96 (1928).—A plan has been worked out by the Credit Alliance Corp. of New York City, whereby expensive equipment, such as tunnel kilns, elaborate brick handling machinery of the type used in Chicago and on the Hudson River, and other machinery involving the outlay of large sums of money, could be bought and paid for out of the savings it was able to effect in production cost. E.J.V.

Mixing and blending of clays. C. R. MINTON. *Brick Clay Rec.*, **73** [2], 100–102 (1928).—Since no one clay can satisfy the changing physical and chemical requirements of bodies for heavy clay products it is necessary to compound the bodies from a mixture of clays, grogs, sand, and other minerals. A method of clay handling which has proved very satisfactory from the standpoint of accuracy and economy and is in operation at the Los Angeles plant of Gladding, McBean, & Co., is described, giving its principal features of arrangement and operation. E.J.V.

American Face Brick Association. ANON. *Brick Clay Rec.*, **73** [3], 158–59 (1928).—Changes in the list of officers of the Association are recorded. In order to obtain a 100% membership among the face brick makers the dues were reduced from 25 to 10 cents per thousand brick, and the dues for research work have been cut from 5 cents to 1 cent per thousand. Already many concerns are lining up as members and many more are expected to follow. E.J.V.

Foreign brick importations. ANON. *Brick Clay Rec.*, **73** [3], 160–61 (1928).—The foreign brick import menace is overshadowing the American brick manufacturer and in some sections of the country is very seriously threatening his business. Belgium and other European countries are exporting over 90,000,000 brick at ridiculously low prices running at an average of $5.91 per M. This condition has caused the average wholesale price of common brick to drop from $17 per M. in January 1927 to $11.25 in December. Because of their low wages of approximately 90 cents a day the European plants are able to ship their product here at such low prices that the American manufacturer is compelled to meet unjust competition. Efforts are being made to stem this tide of foreign competition through legislation and promotional work. All possible support should be lent by American manufacturers in ridding the industry of this menace. E.J.V.

Paving brick lowest in maintenance costs. ANON. *Brick Clay Rec.*, **73** [3], 162–64 (1928).—Results of experiments conducted by the U. S. Bureau of Public Roads over a period of 16 years show that paving brick is durable, low in maintenance, and the most acceptable road wearing surface of the modern materials even for the heaviest traffic requirements. Data on the various types of experimental roads tested are presented. E.J.V.

Drying extremely tender clays. HOWELLS FRECHETTE. *Brick Clay Rec.*, **73** [3], 168 (1928).—In many places in Canada the only clays and shales available for use in making stiff-mud brick are characterized by extreme fineness of texture and high plasticity, requiring a high percentage of water to temper them, and are tough-working and sticky. The physical properties of these clays made it almost impossible to dry them without cracking. It was found that even by adding 50% grog to the clays it was insufficient to stop the cracking. By preheating the clays for half an hour at from 800 to 950°F it was found possible to dry brick made therefrom quite rapidly. The addition of certain chemicals which have a flocculating effect on the clay particles was tried and it was found that ferric chloride was not only effective in small quantity but it also improved the color of the brick. Experiments showed that it was possible to obtain the desired results at a low cost by using an addition of 15% of grog, ferric chloride, and common salt which replaced part of the more expensive chemical. The tests are now being run on a larger scale to make them commercially practical. E.J.V.

Sell brick for remodeling. ANON. *Brick Clay Rec.*, **73** [4], 238–45 (1928).—A well illustrated article pointing out a lucrative market waiting to be sold upon the merits of clay products construction, and thus create a business demand when building has slowed down. E.J.V.

A successful small plant. ANON. *Clay-Worker*, **90** [1], 22–24 (1928).—A description of the 9-kiln plant of the Empire Brick Co., Columbus, Ga., where the average output of high quality brick is about 65,000 daily. The Minter System is used in this up-to-date plant and the cost of labor and operating expense is quite low. Plant details are given. E.J.V.

Factory design and equipment. XVI. T. W. GARVE. *Clay-Worker*, **90** [1], 29–31 (1928).—Power transmission is discussed, taking up in detail such matters as size of shafting, pulleys, bearings, drives, methods of calculating transmittable H.P. for line shafting, speed reducers, and speed variations. For preceding abstracts see *Ceram. Abs.*, **7** [9], 616 (1928). E.J.V.

Brick and brickmaking in the U. S. IX. GEORGE M. FISKE. *Clay-Worker* **90** [1], 39–42 (1928).—This article contains "Brick Plant Engineering," by Willard D. Richardson, in which are discussed brick driers, natural driers, hot floor driers, pipe rack driers, drying on cars, tunnel, and humidity driers. For preceding abstracts see *Ceram. Abs.*, **7** [9], 616 (1928). E.J.V.

Sand-lime brick process, a modern scientific method. ANON. *Chem. Age*, **18** [457], 295 (1928).—More than 12 sand-lime or calcium-silicate brick plants are now at work in Great Britain, and obviously the prejudice against this highly scientific method is now dying out. Hundreds of millions of sand-lime brick are being made every year, especially in France, Belgium, Germany, U. S., and Canada, and on the same lines, material such as blast-furnace slag, ash, clinker, and spent shale can be turned into high grade brick. It will be remembered that the method consists essentially in mixing sand with 5 to 10% of its weight in good quality lime which has been thoroughly slaked so that no trace of quicklime is left (an interesting scientific point) together with a small amount of water. Afterwards the plastic mass is passed through a continuous brick press and subsequently the shapes are stacked on a series of small wagons and heated in a long iron cylinder or autoclave for, say, 4 to 8 hours by blowing in steam at 120 to 180 lbs. pressure, resulting in a chemical combination between the lime and the sand, presumably to form hydrated calcium silicates. This binds the mass together, giving an extremely hard smooth brick, resembling natural stone, the exact duration of the heating depending on the steam pressure, while for slag, ash, and clinker, it is only necessary to use steam at atmospheric pressure. The brick possess all the advantages of ordinary fired clay brick in the way of strength, durability, and porosity, while there is no sign of bulging, warping, and twisting, so that every brick is a "facing" brick. As a result only a very thin line of mortar is required; the brick are fine grained and a light pink or gray in color, depending on the sand used, and with ash and clinker, the color is deep blue like Staffordshire brick. In fact, the superiority of the sand-lime brick is shown by every known chemical, mechanical, and physical test to which brick can be subjected. The British Standard Assn. has now a standard specification for it (No. 187, price 1*s.* 2*d*). One of the pioneers of the process, originally introduced in 1894, is the Sutcliffe, Speakman, and Co., Ltd., of Leigh, with plants now under construction at Bournemouth and Glasgow, while some of the later installations are the Arun Brick Co., Ltd., at Littlehampton (Sussex), and the Mansfield Sand Co. and the Standard Sand Co., both at Mansfield. R F.S.

Protection of fireproof masonry. M. LEELLEN. *Le Ciment*, 169–70 (1928); *Rock Prod.*, **31** [15], 85 (1928).—Water is sprayed between the inner and outer walls of the firing chamber which, however, entails a considerable loss of heat by conduction. The

experimenter, M. Leellen also described a method in which the fireproof material is impregnated with "Neutron," a colloidal graphite. After the first hour of firing, a glaze appears on the masonry in the form of a scale which may be knocked off and another coat of "Neutron" applied. This procedure is repeated until after the third time the stone is well impregnated and hardened. F.P.H.

Modern sand-lime brick plant. ANON. *Rock Prod.*, **31** [15], 61–64 (1928).—A description is given of the plant of the Atlas White Brick Co. at Berlin, N. Y. F.P.H.

PATENTS

Method and means for producing earthenware pipes and products resulting therefrom. FEDERICO, JUAN B., TOMÁS, SERAFIN, AND FLORENCIO ALASSIO. U. S. 1,677,808, July 17, 1928. In a method of making an extruded article from plastic material, the steps of advancing the material under pressure, subdividing the material while under pressure, bringing the portions resulting from the subdivision together while maintaining the material under pressure and in addition to giving the material the advancing movement, subjecting the material to a displacing movement in a circular direction in a plane transverse to the advancing movement prior to the extruding of the article.

Underground conduit. HOWARD W. JEWELL. U. S. 1,679,427, Aug. 7, 1928. A junction in a run of multiple duct conduit comprising a multiple duct section having a plurality of layers of ducts, and a partition wall between contiguous layers thickened at the junction end, and two separate conduit sections having ducts corresponding respectively to the layers of ducts in the multiple duct section and laid with external walls at the junction end in contact and in continuation with the thickened partition wall of the multiple duct section, the thickened partition wall being substantially of the same thickness as the combined thickness of the external walls.

Refractories

Commercial development of a kaolinic fire brick. F. H. NORTON. *Jour. Amer. Ceram. Soc.*, **11** [9], 679–84 (1928).—The development of a kaolinic brick from Georgia clay is described. The high and continued shrinkage of this clay makes it necessary to fire the brick at a very high temperature. A temperature of over 3000°F was required. The development of a kiln for the firing of the grog and brick was a problem that was satisfactorily solved. A light weight brick for use in marine boilers and a dense refractory for use in glass tanks were developed. The following physical properties of these two refractories are given and compared with other high grade bricks: (1) start of deformation under 25 lbs. per sq. in. load, (2) 10% deformation under 25 lbs. per sq. in. load, (3) start of permanent volume change without load, (4) mean coefficient of expansion, (5) cycles in 2900°F air-spalling test, (6) melting point, (7) thermal conductivity at 1000, 2000 and 2750°F. Various successful applications of this type of brick are described.

Premature failure of combustion chamber material. A. J. DALE. *Trans. Ceram. Soc.* [Eng.], **26** [4], 290–96 (1926–27).—Fine-grained, friable material with a silica content in the region of 88% and containing considerable free quartz, needs special care during the end of the "slow-fire" period, particularly if the iron and alkali contents of the brick are high and if the color suggests a homogeneous distribution of the iron compounds. If laboratory-examination by means of modified Mellor and Moore load-tests indicates only moderate refractoriness, and mechanical weakness near working temperatures, constructional details (arch contour, suitable expansion arrangements, the use of contractile mortar, etc.) would seem to merit special attention. From the maker's viewpoint the high-temperature mechanical weakness might be minimized, or transferred to a still higher temperature by small additions of a plastic vitrifiable bond clay, and a

corresponding modification of the kiln firing. At the same time, this procedure may mean sacrificing certain desirable characteristics of the fired product. This work has indicated that combustion chamber material should satisfy two criteria: (*a*) moderate or high refractoriness; (*b*) good cohesion between grog and matrix up to maximum working temperatures. A proper interpretation of two Mellor and Moore load tests (high and low loadings) will evaluate, qualitatively, the degree to which these desirable characteristics are possessed by any given product. R.F.S.

Effects of temperature on the mechanical properties of silica products. A. J. DALE. *Trans. Ceram. Soc.* [Eng.], **27** [1], 23–55 (1927–28).—This report has been restricted to the presentation and limited discussion of the results obtained from an examination of 33 silica brick under various load and temperature conditions; a separate paper deals with the practical applications of this work. Any orderly relations between such data as ordinary refractoriness, density, porosity, or even chemical composition, considered separately, and the behavior of silica brick under stress at different temperatures, are very indistinct, if indeed they exist at all. Making, mixing, and firing procedures and particularly the nature of the bond are, undoubtedly, factors of first importance. From the users' viewpoint, it would seem futile to describe a silica brick as good, bad, or indifferent unless the conditions under which it is to be used can be defined. With the probable thermal and mechanical conditions of use known, there seems every reason to believe that two modified Mellor and Moore test results (50 and 4 lbs. per sq. in.) on a given product will suggest the suitability of the brick for the prescribed purpose; in addition the test results will also suggest the degree of precaution necessary in order to get maximum service from the brick with a minimum of trouble and expense. R.F.S.

Open-hearth steel works' refractories. A. T. GREEN. *Trans. Ceram. Soc.* [Eng.], **27** [1], 63–90 (1927–28); for abstract see *Ceram. Abs.*, **7** [4], 236 (1928). R.F.S.

Silica brick made without added bond. W. HUGILL AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **27** [2], 97–101 (1927–28).—It was found that, with a suitable grading of the silica rock, it was possible, by the ordinary hand-molding methods, to make brick of normal commercial size, which were strong enough to permit handling in the green state and were of fair mechanical strength when fired. Brick without any addition of bond were, therefore, made from Totley ganister, Bwlchgwyn quartzite, Penwyllt quartzite, and in each case brick with 2% lime bond were made from the same grading. The stone used was thoroughly washed in order to remove any adhering "clayey" matter. In each case the brick without added bond, although quite strong enough to permit handling, were decidedly weaker than the lime-bonded brick, and the bulk density of the "no-bond" brick is slightly less than that of those with the lime bond. The brick were fired in a round downdraft commercial kiln, the maximum temperature of the kiln equivalent to cone 16 down in the case of the Totley ganister brick and cone 17 down when the Bwlchgwyn and Penwyllt brick were fired, the kiln being "soaked" for 24 hours as usual. The expansion during firing of the no-bond brick was much greater than that of the lime-bonded brick. The no-bond brick were of fair mechanical strength, although much weaker than the companion lime-bonded brick, but had an "addled" sound when lightly tapped with a hammer. The degree of quartz conversion is greater in the brick without added bond than in the lime-bonded brick, but in the former the inversion is almost entirely to cristobalite, while in the latter, tridymite has been formed in fair proportion. The results indicate that the addition of a "melt-forming" bond does not accelerate the rate of quartz inversion but does facilitate the formation of tridymite. R.F.S.

Increasing dried ware strength with lignin extract. ROBERT M. KING. *Brick Clay Rec.*, **73** [2], 97–99 (1928); reprinted from *Ceram. Ind.*, **11** [1], 43–45 (1928); see also *Ceram. Abs.*, **7** [9], 649 (1928). E.J.V.

Half century with fireclay industry. ANON. *Brick Clay Rec.*, **73** [2], 103–105 (1928). —A brief sketch tracing the history and development of the Denver Fire Clay Co., established in 1876 by J. O. Bosworth as a wholesale drug business but converted to the manufacture of laboratory equipment (fireclay crucibles). Some of the later developed products of the concern are described and discussed. E.J.V.

Short course in refractory materials for glasshouse men. K. ENDELL. *Glastech. Ber.*, **5** [12], 601–602 (1928).—An outline of the short lecture and laboratory course given by Endell at the Technical High School in Charlottenburg, for glass factorymen, in Oct., 1927. E.J.V.

Effect of insulation on open-hearth furnaces and soaking pits. WALTER T. KENNEDY. *Blast Fur. Steel Plant*, **16** [7], 952 (1928).—It is generally acknowledged by steel plant and fuel engineers that parts of these furnaces can be insulated to very good advantage, the limiting factor being the ability of refractories to give a satisfactory life under the conditions to which they are subjected. It is now general practice to insulate (1) around the checker chambers, flues, and boilers; (2) a number of furnaces have been insulated around the slag pockets up to the charging floor level; and (3) around stack bases to protect the concrete from calcining and cracking. With the exception of one small acid furnace, all new open-hearth furnaces and several pits built in the U. S. in 1927 were insulated, and about 70 open hearths and pits have been built or are being built by more than twenty of the leading steel companies and in all cases the results have been completely satisfactory. By the usual method of application this insulation reduces the radiation losses 60 to 75%, retaining this heat for useful work in the furnace; it also prevents air infiltration due to the microscopic entrapped air cells. A Sil-O-Cel standard brick is impervious to air penetration at a pressure as high as 1 lb. per sq. in.; by reducing the outside temperatures of the heated surfaces, steel jackets are practical, which protect the walls and give added protection against air filtration. In case steel jackets are not desirable due to the difficulty of locating gas leaks, insulating brick are bonded between fire brick and red brick. The results obtained through insulation are higher preheated air and gas temperatures, also higher temperatures to the boiler, faster, sharper working furnace, direct saving of fuel, high heat storage capacity during shut down over week-ends, prevention of brick spalling from too quick changes in temperature due to sucking cold air, (especially with silica fantails); eliminating the tendency for checker side walls to belly in, due to the fact that insulation gives a more even heat gradient and uniform expansion through the brickwork. F.P.H.

The properties of magnesite brick. HANS HIRSCH. *Tonind. Ztg.*, **52** [25], 479–83 (1928); see *Ceram. Abs.*, **7** [9], 620 (1928). F.P.H.

Aluminum from clay in Germany. HAGELUND. *Chem. and Ind.*, **47**, 753 (1928).—The Hagelund process for producing Al from clay electrolytically is being extensively introduced into the German Al industry. Considerable reduction in cost without the quality of the metal being affected is claimed. H.H.S.

Crucibles for steel melting. ANON. *Brit. Clayworker*, **37** [434], 122–24 (1928).—Clay crucibles in which steel is melted hold approximately 125 lbs. of steel when filled to the brim but the usual charge is 60 lbs. These crucibles are made from a suitable mixture of fire clays to which 5% of coke dust is added. The clays are mixed together in the dry state and sieved and then brought to the consistency of fresh putty with water. The crucibles should be allowed to dry about 4 weeks then heated slowly to about 800°C which requires about 20 hours. When used they are placed in position at the furnace and surrounded with coke up to the lid and the temperature allowed to rise to about 1100°C when the bottom is made good with sand. During the past 10 years plumbago crucibles have been largely adopted in the steel industry. Their only disadvantage is that they may give up an unknown and varying quantity of carbon to the charge but this

feature is being gradually eliminated. Due to the higher heat conductivity it is possible to melt 3 charges in the same time taken for 2 in the clay crucible. The greater durability of plumbago pots is partly due to their much higher conductivity and that the ash of the coke does not adhere to the bottom of the pots. Pots which crack or break in the furnace are known as runners. These are chiefly due to two causes: (1) defects in the pot when it leaves the pot house, (2) defects developed in the furnace which may be subdivided into (*a*) defects developed during annealing, (*b*) lack of skill of the furnace men, (*c*) use of unsuitable material. Most runners are caused by the pots being allowed to attain such a high temperature that their strength is no longer sufficient to withstand the outward pressure of the contents. R.A.H.

Defects in clay crucibles. ANON. *Brit. Clayworker*, **37** [435], 149 (1928).—Defects in crucibles arise from various causes and probably the most important are cracks, scalping, and peeling which frequently occur in crucibles employed in melting metals and alloys. Cracks may be caused by (1) two portions of clay not being completely joined; (2) presence of oil which prevents perfect adhesion of clay particles; (3) lack of uniformity in drying and firing. Cracks appearing after crucibles have been in service are due to hastily conducted heating or cooling. Crucibles composed of laminated material display scalping or peeling. Frequently the term "porosity" is used as a misnomer when leakage or permeation of contents into crucible walls takes place. This trouble is usually caused by minute cracks in the walls frequently the result of pinholes. Either careless annealing or the use of a laminated instead of a homogeneous material may cause this defect. Corrosion of the crucible by a portion of its contents is another source of leakage. R.A.H.

Bauxite industry in 1927. ANON. *Min. Jour.*, **160** [4827], 155 (1927).—The following is an estimate of world production in metric tons:

Country	1927	1926	Country	1927	1926
France	530,000	408,000	British Guiana	160,000	186,000
United States	329,000	392,000	Jugoslavia	130,000	150,000
Hungary	240,000	5,000	Italy	85,000	200,000
Dutch Guiana	170,000	45,000	Other countries	40,000	30,000
			Total	1,684,000	1,416,000

Of the 355,000 T. of bauxite imported by the U. S. last year, 160,000 T. came from British Guiana and a like amount from Dutch Guiana, the Dalmatian shipments being only 25,000 T., and the French 13,000 T. The foreign ores are much richer than those of Arkansas and Alabama, the production of which is steadily falling. To produce 1 T. of alumina, 3 or 4 T. of coal are required; 2 T. of bauxite produce 1 of alumina, and 2 T. of alumina produce 1 of aluminum. About 60% of the world's bauxite production goes to the aluminum works which took between 800,000 and 900,000 T. of last year's output. The remainder was used in the chemical works and for the manufacture of abrasives and refractory materials. A.J.M.

The graphite market in 1927. ANON. *Min. Jour.*, **160** [4831], 238 (1928).—The market continued in a depressed state during the year. There was no encouragement for the small mine owners to recommence operations. The demand for Ceylon lump graphite for crucibles fell off considerably but there was a greatly increased demand for carbon lump. The falling-off in the demand for crucible graphite is largely due to the more extended use of Madagascar graphite for this purpose. The exports of Ceylon graphite for 1927 show a slight increase over 1926. America was again the biggest buyer and consumer, taking 97,142 cwts., with Germany second, taking 60,560 cwts. A.J.M.

New Caledonia chrome ore in 1927. ANON. *Min. Jour.*, **161** [4837], 376 (1928).—The exports of chromite in 1927 were 42,880 T. as against 23,590 in 1926. A.J.M.

The modern foundry plant. C. A. Otto. *Mech. World*, **83** [2150], 187–99 (1928).—The article is a detailed description of the types of furnaces and other equipment used in a modern foundry plant. E.P.R.

Industrial furnaces. Victor J. Azbe. *Mech. World*, **83** [2151], 215–16 (1928).—Combustion and heat problems encountered in boiler plants are much more simple than are those met with in industrial furnaces, kilns, and ovens. A boiler furnace, industrial furnace, oven, or kiln must be divided into heat-generating and heat-absorbing portions when an attempt is made to study the overall efficiency. A discussion of the different types of industrial furnaces together with their losses and efficiencies is given. E.P.R.

Steel foundry practice. A. D. Kirby. *Mech. World*, **83** [2157], 326–28 (1928).—Steel foundry practice is discussed in three parts, (1) sands used, (2) method of molding, and (3) manufacture of the steel. E.P.R.

Measurements of the expansion of refractory bricks at 1600°. K. Endell and W. Steger. *Arch. Eisenhüttenw.*, **1**, 721–24 (1927–28); *Stahl u. Eisen*, **48**, 722 (1928).—After a critical discussion of the merits of the methods used for determining the expansion of refractories at high temperatures by previous workers, results obtained by a new method devised by the authors are recorded. Fireclay brick with a medium or high content of alumina expand only slightly but evenly over the range 20 to 300° and then begin to contract. Fireclay brick with a high content of quartz exhibit the usual irregularities in expansion caused by the various transformations which take place on heating quartz. Magnesite brick expand considerably but evenly up to 1500°, then begin to contract. Silica brick of *d* 2.35 retain a constant volume between 600° and 1600°; those having *d* 2.40 are constant up to 1450°, and those having *d* 2.45 to 2.54 expand considerably up to 1250° and at 1600° their total linear expansion is 2.85 to 3.35% of the original length. (*B.C.A.*)

Cupola refractories. J. G. A. Skerl. *Bull. Brit. Cast Iron Research Assn.*, **20**, 18–21 (1928).—The properties and care of refractory brick for cupola linings, the use of ganister for patching, and the making of monolithic linings are briefly outlined. (*C. A.*)

Silica and magnesite bricks in metallurgical furnaces. Gerhard Wolff. *Metal Ind. (N. Y.)*, **25**, 489–92 (1927).—For silica brick the best material consists of quartzite with 0.5–1% Fe_2O_3 and less than 1.5% Al_2O_3. The presence of more Al_2O_3 increases the porosity and decreases the softening point 125–175° for 2–6% Al_2O_3. Fe_2O_3 acts as catalyst for the quartz-tridymite transformation. Silica and magnesite bricks are more sensitive to thermal shock than the other refractories used generally. Magnesite brick should contain 5 to 7% impurities, chiefly Fe_2O_3 to form $MgO \cdot Fe_2O_3$ and the sintered condition. Methods used in the Pb, Cu, etc., metallurgical practices to protect the magnesite brick from sudden temperature change are described. (*C. A.*)

PATENTS

Side arch brick. Edward M. Carroll. U. S. 17,052, July 31, 1928. (Reissue) A side brick for locomotive arches, curved throughout its upper surface and curved substantially throughout its lower surface, the brick being provided with a depending flange on one side, which flange is at right angles to the body of the brick, the outer surface of this flange being flat to form a relatively wide contracting area, and this flange being provided with a depression to receive a supporting means, and the opposite side of the brick being undercut to form a supporting ledge.

Sagger. Joseph A. Jeffery. U. S. 1,677,452, July 17, 1928. A silicon-carbide body covered by a refractory alumina-silica compound which does not change materially in volume from the green state in which the compound is applied to the body when fired

to a high temperature, the layer of the alumina-silica compound being of sufficient thickness to be injured by any material change in volume relative to the silicon carbide.

Pavement. CLARENCE H. JACK. U. S. 1,677,829, July 17, 1928. A paving block comprising a body portion formed with a lengthwise extending groove in its bottom, the groove being of key-hole shape in cross-section, the lower part of the wall of the groove being oppositely flared to provide the lower portion of the blocks with tapered parts, the body portion at each side of the groove formed with lengthwise extending openings.

Fusing and purifying refractory substances; gems; electrolysis. J. SKAPPEL. Brit. 290,586, July 11, 1928. Crystalline alumina and other crystalline oxidic metal compounds of high melting point, such as spinel titanium dioxide, titanite, zirconia, and beryl, are obtained from impure raw materials containing them by sintering or fusion with halogen salts, such as fluorspar, cryolite, or sodium or calcium chloride, or with oxidic alkali or alkaline earth metal compounds, for instance with aluminates, removal of impurities by reduction, electrolysis, or conversion and cooling of the reaction mass under regulated conditions to obtain the required crystals and an eutectic mixture which are then separated by mechanical dressing. Iron and other heavy metals, and silicon and titanium, may be removed by reduction, as by briquetting the mixture to be fused with coal or by adding raw aluminium to the melt, and the melt obtained may be electrolyzed, using the oxide-halogen slag as electrolyte, for the more complete removal of readily reducible constituents, the electrolysis being prolonged, if desired, to deposit also some of the valuable constituent, such as aluminium, present. In the reduction step pure iron oxide ore may be added to the charge to assist the removal of silicon. Alternatively, iron and heavy metals and silicon and titanium may be crystallized out of the melt as oxidic compounds, for instance, as magnetite, spinel, titanite, topaz, zirconia and beryl, or iron and other heavy metals may be removed as sulphides, as by adding sodium sulphate and carbon to the charge. From the solid mass obtained by the treatment, the crystals required may be separated by dissolving out or decomposing the eutectic, as by treatment with water or exposure to the air, with disintegration if necessary. In some cases, a fine sludge is obtained which may be separated from the main body of crystals by elutriation. By choosing suitable initial materials and additions, adding coloring matters if desired, and subjecting the melt to very slow cooling, precious stones, such as rubies, may be obtained, and these may be caused to crystallize out first. By treating bauxite with fluorspar and sodium chloride a mixture of crystalline alumina and fluorspar is finally obtained, from which the alumina may be separated by hearth dressing after classification, or by a differential flotation process, or by frictional disintegration. Cryolite and crystalline alumina may be obtained by fuzing or sintering together bauxite, fluorspar, a sodium salt, carbon, and a sulphidizing agent such as a heavy metal sulphide, cooling the melt, and treating the mass by methods above described. Sufficient heavy metal sulphide may be used in the fusion step to extract calcium and other sulphides formed from the cryolite-oxide slag, which latter may then be electrolyzed, for instance, in stages, to obtain raw and pure aluminium, and cryolite; or the slag may be passed in counter-current to a heavy metal sulphide, or a small amount of aluminium sulphide may be added to the slag to extract calcium and magnesium therefrom as sulphides, or the slag may be treated with mats or with metals containing sulphide. Spent cryolite melts of the aluminium industry may be treated as just described for removal therefrom of calcium.

Refractory clay articles. J. HOCHHUT. Brit. 291,305, July 25, 1928. Refractory clay articles, such as glass melting-pots, are formed by moistening with water a mixture of shortening-material and clay to produce a loose, incoherent mass, introducing such mass successively in small portions into an open mold and stamping the portions so introduced. The shortening-material is moistened with the whole of the water, with or

without addition of a small quantity of fresh dry ground clay, before mixing with the clay. To facilitate removal of complicated shapes from the mold, a small addition of oil may be made. The articles are removed from the mold immediately after completion and dried and fired in the usual way. As an example, 40–45 liters of water are gradually mixed with 300 kg. of disintegrated burnt clay and 215 kg. of disintegrated crucible shivers; 425 kg. of air-dried ground clay are then gradually added with continuous agitation to produce the mass. The stamping is preferably effected by pneumatic stamps.

Furnaces. C. B. DANN AND F. THORESBY. Brit. 291,335, July 25, 1928. Fire-bridges of the kind comprising a hollow vertical partition closed at the top by a plurality of cover pieces are supplied with steam by a pipe having two discharge portions provided with perforations and angularly adjustable relatively to one another so that the angle between the two sets of steam jets can be varied. The jets first converge and then spread out fanwise. Before discharge the steam is passed through a superheating coil. A light vaporized oil is supplied to the bridge by a pipe formed with a series of convolutions near the grate bars the vapor passing to curved pipes and issuing through openings in the cover pieces.

Process for manufacture of a siliceous precipitate. ERICH KRAUSE. Ger. 454,363, Oct. 21, 1925; *Tonind. Ztg.*, **52,** 620 (1928); *Rock Prod.*, **31** [15], 84 (1928).—To obtain siliceous precipitates of great chemical resistance, the process recommends leading gases over the products which are to receive a coating, these gases consisting of a mixture of some neutral gas such as carbon dioxide or nitrogen with a carbon and hydrogen compound of silicon. Thus, for example, if a porcelain crucible is to be lined with such a precipitate, pure carbon dioxide is led through some heated hydrocarbon compound of silicon, such as silicon tetraethyl, and the resulting gases are made to pass over the crucible, which is brought to red heat upon elimination of air. The coating thus formed may consist of free silicon or of silicon carbide. It withstands prolonged and powerful heating in a blast in the presence of air. It is baked into the glazing without becoming oxidized. The hydrocarbon compound of silicon may receive admixtures of halogens; for example, diisobutyl-silicon dichloride may be used. Aside from porcelain, glazed or otherwise, the coatings may be applied to glass, metals, enamels, etc., as well as wire.

F.P.H.

Terra Cotta

Testing of a red quarry floor tile kiln. W. HARRY VAUGHAN. *Jour. Amer. Ceram. Soc.*, **11** [9], 659–78 (1928).—A practical test of a round downdraft kiln firing red quarry floor tile is given. The results showed a considerable saving in fuel and time and an increase in the quality of ware amounting to more in value than the saving in fuel. An investigation of firing conditions in the average large plant using similar kilns is recommended as an investment which will yield dividends.

Suspension of glazes and barium carbonate water. P. WILLIAM LEE. *Jour. Amer. Ceram. Soc.*, **11** [9], 713–14 (1928).—Heavy setting, fine grinding, raw clay substances, hydrochloric acid, acetic acid, and corn starch are being discussed as the factors and ingredients for the suspension of glazes and wilkinite as a substance which will aid suspension for glazes and barium carbonate water.

Peeling of "slip-banded" ware. W. EMERY. *Trans. Ceram. Soc.* [Eng.], **26** [4], 276–89 (1926–27).—Peeling is a fault which occurs sometimes during the manufacture of "red clay" teapots and also in slip-banded earthenware. Data refer to the "flaking off" of glazed bricks, enameled fire clay, terra cotta, cane and white sanitary ware. The bodies studied were (1) a plastic red-firing clay, (2) a plastic buff-firing clay, and (3) an earthenware body: black ball clay, 25; china clay, 25; flint, 30; cornish stone, 20. When

cane clay is substituted for the red in the underlying test pieces, the working limits are much more circumscribed. The earthenware mixture occupies an intermediate position between these two natural clays. The red clays obviously have the greatest margin of safety both as to variation in the composition of the applied slips and the state of the ware at the time the slips are applied. For earthenware goods, the following is the correct slip to use: black ball clay, 10; dry earthenware body scraps, 90. The experimental data confirms works experience insomuch as it is mainly the condition of the ware at the time of banding which determines the incidence of the defect. That the bond between body and slip is an important factor is well illustrated in the test pieces which were "scrubbed" with slip before dipping. R.F.S.

Salt-glazed ware. ANON. *Brit. Clayworker*, **37** [435], 142–44 (1928).—Salt glazing differs from all other methods inasmuch as no glaze is applied directly to the goods; but the salt, thrown into the kiln toward the end of the firing decrepitates and that which comes in contact with the goods forms a glaze on them. Although at one time extensively used at present it is limited to certain bricks, troughs, latrines, drain pipes, gullies, and traps. The composition has not been definitely established and appears to vary with that of the clay on which it is formed. It may possibly be a solution of sodium aluminum silicate in crude sodium silicate. In order to produce a good salt glaze it is essential that the article should be made of a material sufficiently rich in silica, not less than a minimum of 30% being advisable. A downdraft kiln is almost essential if a really good salt glaze is desired. Under normal operations the condition and temperature best suited for salt glazing will both be suitable if the material of which the goods is made has begun to vitrify. A dark glaze requires at least 1.5% iron in the material expressed as ferric oxide. Details of salt glazing are given and procedures to follow to obtain certain results. R.A.H.

Application of gas in firing terra cotta. LEE HOLTZ. *Brick Clay Rec.*, **73** [3], 159 (1928).—Advantages of natural gas in firing terra cotta are: (1) fuel is delivered to the consumer's burner under any pressure desired, ready for use; (2) since it is composed of the lighter hydrocarbons, the flames and kiln temperatures are more easily controlled; (3) reducing atmosphere, which robs the material of its necessary oxygen, is rare; (4) discoloration is practically eliminated, which means that reglazing and firing is seldom necessary to duplicate a color and complete a delayed order; (5) sulphur content is low, natural gas rarely containing more than a trace; (6) it is exceptionally clean; (7) ware may come in contact with the products of combustion without injury. E.J.V.

Stoneware pottery at Chesterfield. ANON. *Pottery Gaz.*, **53** [614], 1282–85 (1928). —An illustrated description of the pottery of Pearson & Co., Ltd., at Whittington Moor, Chesterfield, manufacturers of stoneware. E.J.V.

Ceramic materials resistant to cooking processes. FELIX SINGER. *Z. angew. Chem.*, **40,** 1295–96 (1927).—Recent improvements in stoneware have resulted in a product of low absorption, with resistance to thermal shock about equal to that of porcelain, while still suitable to be worked into large shapes. (*C. A.*)

PATENT

Tile-making molds. E. G. SPENCER-CHURCHILL. Brit. 290,809, July 11, 1928. A hand-operated mold for roofing tiles comprises a removable pallet resting on a metal-bound wooden base plate, and a cross-bar carried on the pivoted arms which is manipulated so that the adjustable screwed members form the perforations and the vented holes form the ribs. In operation the mold is over-filled with a mass of clay which is then wire-cut level with the upper surface. A small additional quantity is then placed in the middle of the tile, before the bar is depressed to form the perforations and ribs.

Finally the bar is raised and the tile beaten and smoothed with a wooden striker before being removed with the pallet from the mold.

White Wares

Study of china bodies of Belleek type. PAUL F. COLLINS. *Jour. Amer. Ceram. Soc.*, **11** [9], 706–12 (1928).—After a preliminary study of Belleek bodies of four compositions using three different frits and firing to three temperatures, a further study was conducted using the most promising of the three frits as the basic frit and three new frits containing some different ingredients. A standard body was used in the later study. Results obtained are enumerated and discussed.

Competitor for low tension porcelain. ANON. *Ceram. Ind.*, **11** [2], 148 (1928).—A new material called "laminated phenolic" is being put on the market as a competitor of low tension porcelain, and as an electrical insulator it is claimed to be as hard as rubber without its limitations of temperature and short life; it is claimed not to warp, and weighs only one-half as much as cast aluminum and possesses 90% of its tensile strength. Laminated phenolic is a fibrous material of specially prepared paper, cotton, linen, or duck cloth, treated with a bakelite resin in a liquid state. Its method of manufacture is given. It is claimed that this material can be sawed, shaved, sheated, punched, turned, drilled, milled, planed, threaded, and successfully machined in other ways. It is adaptable to decoration in rich colors and designs, and can give attractive finishes in imitation wood grains. F.P.H.

Germans may organize porcelain export cartel. ANON. *Ceram. Ind.*, **11** [2], 160 (1928).—The German porcelain industry has started negotiations to form a joint export organization to eliminate competition on foreign markets and to strengthen their position against foreign competitors. Approximately 130 German firms now are engaged in exporting, only a few of which are strong enough financially to promote the sale of their products in foreign markets. F.P.H.

Porcelain plant at Sun Prairie. ANON. *Ceram. Ind.*, **11** [2], 162–65 (1928).—A description is given of the plant of the Standard Porcelain and Specialties Works. F.P.H.

The blending of clays. R. C. CALLISTER. *Trans. Ceram. Soc.* [Eng.], **27** [2], 124–49 (1927–28).—The object was to observe the effects of the blending of typical china and ball clays on the properties of the resultant mixtures and to determine to what extent these resultant properties were additive. The following properties of the clays and mixtures were examined under conditions as strictly comparable as could be examined: the quantity of water present at maximum working consistency; the workability as indicated in part by the plasticity; the very approximate point at which further loss of water during air drying was not accompanied by further lineal shrinkage; the linear shrinkage to dry at 110°C; the transverse strength expressed as modulus of rupture, of pieces dry at 110°C; the tensile strength of pieces dry at 110°C; the fired shrinkage, loss of weight, water absorption, apparent porosity, color, and effects of firing from dry at 110°C to china glost, earthenware, biscuit, and china biscuit conditions in commercial ovens; the refractoriness, determined by cones, of the clays, not of the mixtures; the ultimate analyses of the clays and the calculated rational analyses are stated. The data covering the above properties of clays of the types worked with can be utilized as a guide to results desired in mixtures. These results are not necessarily applicable to all types of clays, but indicate that by blending clays of determined properties certain properties of the mixtures can be closely controlled. These properties are (1) the air-drying linear shrinkage; (2) the firing shrinkage from dry at 110°C to china glost, earthenware biscuit and china biscuit conditions; and (3) the loss of weight on firing; while

other properties which can be less closely arrived at and controlled are: (1) the modulus of rupture; (2) the tensile strength; (3) the apparent porosity and absorption; (4) the degree of vitrification; and (5) the color. R.F.S.

Transparency of porcelain. G. A. SEMENOFF AND A. U. AVDEEFF. *Ceram. and Glass*, No. 2, 103–107 (1926).—The effects of different compounds and methods of manufacturing on the transparency of porcelain are discussed. The measurements of the transparency were determined with respect to the red rays only. The photometer with two movable electric lamps was employed. The transparency of one porcelain plate showing an average transparency was taken as an arbitrary standard and a graphic method was used. The transparencies were plotted on ordinate while corresponding thicknesses of porcelain plates were plotted on abscissa. The following factors affect transparency: composition of porcelain, degree of milling of the rough materials, their physical properties, and methods of firing. This last factor was not exactly determined. It was found that transparency increased with the temperature increase. Influence of composition: in porcelain containing 60 to 20% of clay the transparency increases with a decrease of the clay content and this is more pronounced with a larger quartz content. In porcelains rich in quartz the transparency rather decreases with an increase in the quartz content. Influence of milling: transparency increases with the finer milling of quartz. There is some relation between transparency of porcelains and degree of dispersion of kaolin, the transparency being increased with an increase of dispersion. Artificial increase of dispersion may be produced by removing electrolytes, introduction of colloids (*i.e.*, dextrine, starch, gelatin), separation of strongly dispersed particles by passing electric current of 1 to 2 amperes and 110 volts. Experiments were made substituting silicon and silica sand for quartz. In the first case there was a noticeable increase while in the second case some decrease in transparency. A.I.K.

Cornish china clay industry in 1927. ANON. *Min. Jour.*, **161** [4833], 279 (1928).—In 1927 the production of china clay reached a record output of 997,269 long tons. The highest previous record was attained in 1912, when there was an output of 963,895 T., including 73,284 of china stone. The 1927 total, comprised 920,074 T. of china clay, 54,551 of china stone, and 22,644 of ball clay, compared with an output of 934,360 T. in 1926. The English china clay beds are located over a wide area in Cornwall and Devon. The deposits vary greatly in size and quality of the clay. The overburden is fro m 10 to 50 ft. or more in depth. Practically every pit produces from 3 to 10 or more commercial grades, depending upon the color of the refined clay and its fineness. There is at present no standard of grading clays adopted by the china clay concerns. The new association of china clay firms, scheduled to begin functioning early in 1928, has announced the sampling of clays and placing them in their appropriate grades. The commercial term "china clay" covers all varieties, whether for papermaking, pottery, or other purposes although ball clay is used mostly for pottery and crucible clay in the limited cases where high heat-resisting quality is demanded. China clays shipped from this district to the U. S. are not given any particular grade, but rather trade-brand symbols. Since 1924 the china clay industry in England has been without any organized coöperation. In the latter part of 1926 it was thought that complete agreement of all firms had been obtained for the formation of a new association but the plan failed owing to the objection of one firm. During 1927 public announcement was made of the formation of an Associated China Clays (Ltd.) to begin to function during 1928. The objects of this organization are (1) the coöperation of the member firms, (2) the adjustment of prices, (3) the elimination of underbidding among producers, (4) perhaps the pro rata allotment of foreign orders to member firms, and, (5) in general, consultation and concerted action looking to greater efficiency of the industry and the expansion of its trade at home and abroad. The following table contains the available export figures for 1927 as compared with the statistics for 1925 and 1926:

Destination	1925 Long tons	1926 Long tons	1927 Long tons
Belgium	56,755	64,891	65,448
France	33,090	31,129	28,975
Germany	26,721	27,893	33,885
India			36,941
Italy	32,044	23,697	22,781
Netherlands	42,113	40,421	50,512
Scandinavia	63,637	49,203	71,564
Spain	13,445	15,646	18,502
United States	345,506	361,797	274,093
Other countries	39,265	37,313	59,125
Total	652,576	651,990	661,826

Another important development of the English china clay industry in 1927 was the investment by an American concern of considerable capital in Cornish china clay properties. This is the first step taken by American papermakers to provide their own production of English china clay, and marks an important development in the handling of the china clay output of Cornwall. The two English firms taken over by the American purchasers are both located at St. Stephens, near St. Austell. The combined output of the china clay mines operated by these firms is reported at 50,000 T. per year.

A.J.M.

Penetration of porcelain at high temperatures. LYDIA INGE AND A. WALTHER. *Arch. f. Elektrot.*, **18,** 542–48 (1927); *Sci. Abs.*, **31,** 43 (1928).—It was shown in earlier work that in homogeneous insulators, penetration at high temperatures must be explained by the theory of heat. They show now that with porcelain at high temperatures there is a heat penetration. The absolute value of the penetration tension is determined from the material constants of the porcelain by means of the formula of V. Fock and is compared with observed results. The accord is satisfactory and discrepancies are blamed on experimental defects. D.E.S.

Electrical insulating materials. A. GUNTHERSCHULZE. *Z. Elektrochem.*, **33,** 360–69 (1927); *Sci. Abs.*, **31,** 47 (1928).—The properties of the various insulating materials used in the electrical industry are reviewed. D.E.S.

PATENTS

Insulator. RAY P. JACKSON. U. S. 1,677,346, July 17, 1928. An insulator comprising an insulating member including a head, a portion having an annular water-shed surface diverging from the lower end of the head and a lower portion having an annular creepage surface of relatively great length and area sloping inwardly and downwardly from a position closely adjacent to the outer perimeter of the water-shed surface in such position as to receive driving rain directly, the water-shed surface portion projecting only slightly beyond the upper end of the lower portion to provide a water-drip portion preventing the passage of a continuous stream of water along the water-shed and creepage surfaces but permitting the washing of the major portion of the creepage surface by driving rains.

Sanitary fixture. RAYMOND E. CRANE. U. S. 1,677,550, July 17, 1928. In a sanitary receptacle made of ceramic materials the combination of a main wall, side walls made integral with and extending outwardly from the main wall, end walls integral with the main and side walls and longitudinal tubular supports made integral with and supporting the junction between the main wall and the side walls.

Method and means for shaping teacups or the like with integral handles. JOHN BAILEY. U. S. 1,677,611, July 17, 1928. The process of forming a handle integral with a cup by molding comprising roughly forming by hand a clay handle and placing it in a separable handle molding member so that the ends of the handle slightly project, placing the separable member in the main molding member, and forming a cup therein

in the usual well-known manner, using the tool of the jolly to work the ends of the handle into the clay body of the cup while forming the same and after sufficiently drying the same inverting the mold to permit the clay cup and separable handle molding member to leave the main mold member.

Ceramic sorting machine. RUSSELL P. HERROLD. U. S. 1,677,862, July 17, 1928. A sorting machine for ceramic units embodying a tumbling-drum having a charging opening at one end, a discharge opening at the opposite end, and being divided into communicating sand-sieving and unit-gaging compartments, the former having a screen wall provided with apertures of less width than the thickness of the unit to be sorted and the latter having a screen wall unobstructed on its interior surface and provided with elongated gaging apertures of slightly greater width than the thickness of the units to be sorted, means for supporting the drum with its axis in inclined position, means for rotating the drum about the inclined axis, a sand-receiving bin arranged below the sand-sieving compartment, and another independent bin having means arranged closely adjacent to the bottom of the unit-gaging compartment for receiving without breakage units passing through the gaging apertures of said unit-gaging compartments.

Machine for treating tile. LOUIS S. JONES, GARFIELD W. FISHER, AND CARL G. HENRIKSON. U. S. 1,678,064, July 24, 1928. In a machine for treating tile, the combination of conveying means, means disposed above and below the conveying means for brushing the upper and lower faces of the tile during its movement, a 2nd conveying means offset from the 1st-mentioned conveying means, and a 2nd set of brushes associated with the 2nd conveying means for brushing the portion of the tile not operated upon by the 1st set of brushes, substantially as set forth.

Insulator. LEON T. WILSON. U. S. 1,678,663, July 31, 1928. An insulator comprising a body of dielectric material having an inner opening into which a supporting pin may be inserted, a petticoat extending downwardly from the body and surrounding the supporting pin, the outer surfaces of the dielectric body and petticoat being screw-threaded, an outer conductive shell constricted at its upper portion so that it may be screwed into place over the screw threads, the shell having its lower part extending outwardly from the surface of the dielectric body and petticoat so that the outer surface will form a dry path.

Insulating cap for the joints of electrical conductors. FREDERIK MARINUS VAN GELDEREN. U. S. 1,678,752, July 31, 1928. An insulating cap of the type including a body of insulating material having a cavity therein, and a metallic insert in the cavity, the insert having an internally threaded tapered passage therethrough for receiving and binding the bare ends of electrical conductors when the cap is applied thereto and rotated, characterized by the fact that the body of insulating material is provided with a well below the cavity for receiving the ends of conductors which protrude beyond the cavity and the metallic insert therein.

Method and apparatus for casting ceramic pieces. ARTHUR O. AUSTIN. U. S. 1,679,345, Aug. 7, 1928. The method of manufacturing ceramic articles comprising the steps of depositing plastic material from a slip about a yielding core and removing the core from the formed piece.

Molding ceramic articles. T. S. CURTIS. Brit. 291,523, July 25, 1928. Comprises a process of molding ceramic and like ware from nonplastic materials, in which the materials are used in such a form that they remain fluid while under constant vibration but solidify very rapidly on the vibration being stopped, the article being molded or formed while the vibration is in progress. In manufacture it is preferred to use a plant where the finely-ground materials are mixed with an electrolyte such as sodium silicate in a blunger to promote fluidity, and thence pass to a storage tank in the form of stiff

mud where they are kept in motion by slowly-moving agitator. Portions of the charge are drawn as required by suction into a pressure agitator and delivered thence by pressure into vibrating molds as described in Brit. 291,525. The latter are vibrated until the water content has been absorbed sufficiently by the mold to insure immediate setting on the vibration being stopped, the stiffness of the mud used reducing the time necessary for this operation.

Pottery materials. T. S. CURTIS. Brit. 291,524, July 25, 1928. A ceramic body is composed of fibrous mullite crystals and a binder, the crystals being the product of firing a natural alumina silica bearing substance such as cyanite supplemented with additional alumina in splintery form. In the preferred method, cyanite of the fibrous variety is ground by known processes to a power in which the maximum of long fibers is developed, the natural mineral being purified and concentrated up to 90 to 95% cyanite content. To this is added artificial corundum preferably obtained as a by-product when alunite is roasted in the manufacture of potassium sulphate, which by-product contains approximately 88% alumina, 7% silica and 4% potash. Magnesium oxide is added to this by-product until the total alkaline earth content is equal to $^1/_2$ of the total alkali metal content, after which the mixture is melted in an electric furnace and allowed to cool slowly. The ingots thus produced are sorted, crushed and ground, passed over a magnetic separator and then re-ground in a pebble mill. Finally weighed quantities of the cyanite and corundum products are mixed and re-ground with water in a pebble mill, after delivery from which the powdered mixture is ready for use as a material for producing pottery by any of the well-known processes.

Casting pottery, etc. T. S. CURTIS. Brit. 291,525, July 25, 1928. Apparatus for making ceramic articles from a slip which is fluid when agitated and solid when agitation ceases, comprises a mold or molds adapted to be agitated during filling and casting. Two-part molds are supported by a bench which is supported at the corners upon rubber cushions and is vibrated by an unbalanced pulley driven by a motor. Slip is conducted to the molds from a vessel through hose and flexible connections which are vibrated with the molds. The vessel is fitted with an agitator and is supplied with slip through a bottom inlet, the slip being drawn in by vacuum applied through a pipe. When nearly full, the inlet is closed and the agitator slowly revolved to remove occluded air; a large valve is then opened to admit air and is afterwards closed and pressure applied through an air pressure line to discharge the slip through a valve into the hose. The slip is fed slowly into the molds, while they are agitated, until they are completely filled.

Equipment and Apparatus

A new apparatus for a rapid sedimentation analysis. C. J. VAN NIEUWENBURG AND W. SCHOUTENS. *Jour. Amer. Ceram. Soc.*, **11** [9], 686–705 (1928).—A new apparatus for the continuous determination of the cumulative distribution curve of particle size is described. It is based on the known principle of determining the changes in concentration in one definite layer. Instead of drawing off portions of the liquid, the changes are measured by the apparent weight of a suspended body. Two points of the curve are determined independently by measuring the residue in suspension and by an elutriation in the same vessel. A source of errors, the contraction of the cross-section in the neighborhood of the suspended body, is eliminated. The apparatus makes it possible to determine reliable distribution curves with any liquid within a few hours and avoids some sources of errors of previous methods.

New portable air conditioning unit. ANON. *Brick Clay Rec.*, **73** [2], 122 (1928).—A detailed description of the newest product of the Carrier Engineering Corp., designed to complement and not supersede the standard Carrier Central Station System for

producing manufactured weather, and to meet the requirements of small factories and departments where the more elaborate equipment is impracticable due to expense. E.J.V.

Correction of the error caused in temperature measurement through quartz lenses. L. DUCKWITZ. *Centralblatt der Hütten u. Walzwerke*, **31** [42], 603–605 (1927).—Experiments were conducted to determine the error in temperature determinations where an ardometer or optical pyrometer had to be sighted through a quartz lens on account of the intensity of the heat. Results obtained were very interesting. The peculiar property of quartz is that it possesses a different variable absorptive power for the wave lengths of the individual rays which are changing with increasing temperatures. The investigation of the theoretical foundation for the results of the experiments lies outside this particular field of work, but the determination of the correction curves is of great importance for practical purposes. The results show generally the great value of the correction determination for all temperature measurements which, owing to the arrangement of the apparatus, must be made with an optical or radiation pyrometer through an opening covered with a transparent material. E.J.V.

Industrial continuous measurement of high temperatures. KARL HOLZHAUSEN. *Messtechnik*, **4** [4], 91–93 (1928).—Limitations of an industrial arrangement for measuring high temperatures are discussed. Disadvantages of thermo-elements and advantages of the optical pyrometer are pointed out. The use of an auxiliary appliance for measuring in a furnace under pressure and the requirements this must fulfill are taken up. An arrangement is described which fits all demands. E.J.V.

Collection and removal of pottery dusts. W. M. ODDIE. *Pottery Gaz.*, **53** [614], 1280–82 (1928).—The science of dust removal is emphasized. Old and modern systems are compared. A dust-extraction plant should observe the following considerations: (1) The point or points at which the dust is made must be carefully examined and every precaution taken to insure that the hood or other means of covering-in does not impede the actions of the workman. (2) The hood must be correctly designed so as to create an even suction over its entire surface or choking will take place. The hood must then be connected to the main suction trunk, and great care exercised in the manner of entrance into the main, to prevent eddying or creating a tortuous air flow, both of which may put up a resistance which has to be overcome at the expense of horse-power. (3) Wherever the branch pipes to the hoods are connected to the main, the main must be increased in area by the area of the branch entering it. This is to create a uniform velocity and volume at each hood, instead of having a heavy suction near the fan and none at all at the farthest point away from it, as would be the case were the main all one area. A description of a number of modern methods suited to the extraction and removal of various types of dusts is given. The special advantages of particular types of apparatus for particular purposes are given, including the centrifugal fan, which is usually the most suitable general provision in the pottery trade; the cyclone separator, which is suitable to the settling of coarse dusts; the water separator and settling tank, which collects dust from a dust-laden atmosphere by passing the dust on to the surface of a tank of water, a method only suitable for dusts having an affinity for water; the steam saturation method; and lastly, the bag filter. Further discussions are given on dry glaze goods, biscuit brushing in the earthenware trade, towing flatware, aerographing, and recovering color dusts. E.J.V.

Paper covering protects clay in storage. ANON. *Ceram. Ind.*, **11** [2], 140 (1928); *Clay-Worker*, **90** [1], 26 (1928).—At the Northwestern Terra Cotta Co. where Sisalkraft covers were first used, 36-inch cubes of pressing clay are stored for a week before being released and sent to the working floor for molding. Heretofore it has been extremely difficult to keep these cubes from drying out. Many experiments were made with oiled cloths, rubberized materials, and others, but nothing has displaced the old burlap bags used for many years. The burlap bags are comparatively cheap, but they possess

certain disadvantages for this purpose, among which are the necessity for wetting down every day, including Sundays and holidays, the accumulation of excess moisture in cracks, destroying the uniform consistency of the clay; and the fact that air can circulate freely, drying out the outside of the cubes and making it necessary to cut off and rework the outside layers. Under the old system several tons of clay a day had to be sent back for reworking. The covering consists essentially of two outside layers of heavy kraft paper coated on the inside surfaces with two layers of heavy asphaltum, and reinforced in all directions by two layers of long sisal fibers. This new material, Sisalkraft, is easily cut and fashioned. Since the various layers are pressed together while hot, a thoroughly unified product is secured, which is moisture-proof, air-tight, flexible, and so strong and tough as to be almost indestructible. F.P.H.

Preventing wear on filter sacks. ANON. *Ceram. Ind.*, **11** [2], 141 (1928).—Filter press cloths are likely to first show signs of wear where the cloth is in direct contact with the iron rims. This line is of course around the metal frame border of the plates. One pottery has sucessfully overcome this trouble, which varies to a greater or less degree with the smoothness of the finish of the metal rims. By machining a one-half inch drill around each frame and packing the drill with about 5 feet of packing, it was found that an excellent cushion bearing resulted. Instead of the cloth being stretched over the sharp corners of the frames as the presses were filled, it is now cushioned against the packing. A novel method in cleaning filter presses was also observed. A high pressure water line was connected with the presses, and when they required cleaning the work was done by the water rushing through the press leaves, carrying all sediment and clay with it. After the water was turned off and the press drained for a few minutes, live steam was admitted to the press, which quickly dried the cloths. F.P.H.

Pulverizing in the ceramic industry. HARLOW HARDINGE. *Ceram. Ind.*, **11** [2], 166–69 (1928).—Some of the mills or pulverizers employed to grind the materials required in the ceramic industry are briefly described. These include the following: (1) Buhr mill, (2) dry pan or edge runner, (3) batch pebble or ball mill, (4) beater or hammer mill. Data covering various operations grinding in both open circuit and closed circuit with screens and air classifier, are given. Some of the information may be considered more or less special and power and capacity may not check with standard practice; however, products of an unusual nature require unusual treatment.

Material	Mill size	Capacity (per hour)	Feed size	Product fineness	Moisture (%)	H.P.
(1) Crushed silica	4 x 2 ft.	350 lbs.	1/2 in. and finer	99% (200-mesh)	.5	10 1/2
(2) Eastern silica sand	8 x 4 ft.	2400 lbs.	20-mesh	94% −325-mesh	1	76
(3) Clay (hard and undried)	6 ft. x 22 in.	3 3/4 T.	3-in. and finer	90% − 80-mesh	4.5	78
(4) Enamel frit	8 ft. x 30 in.	2400 lbs.	−3/8 in.	Through 60-mesh 70% " 200-mesh	Bone dry	50
(5) Feldspar	8 x 4 ft.	2900 lbs.	3/4 in. and finer	99% −200-mesh	1.5	78
(6) Grog (clay)	4 1/2 ft. x 16 in.	1000 lbs.	through 3-in.	Through 20-mesh	.5	19
(7) Silicon carbide	6 ft. x 22 in.	1800 lbs.	1/4 in.	16 −150-mesh	.5	57
(8) Clay (wet grinding)	8 x 1 1/2 ft.	2 T.	1/4 in. and finer	Through 200-mesh	Wet grinding	39
(9) Silica (wet grinding)	8 x 1 1/2 ft.	3300 lbs.	1/4 in. and finer	−180-mesh	Wet grinding	39

This data is taken from actual reports under average operating conditions. F.P.H.

New horizontal blunger. ANON. *Ceram. Ind.*, **11** [2], 194 (1928).—In order to facilitate the blunging of clay bodies, the Mueller Machine Co. developed the horizontal blunger, and this machine has now been in operation for almost a year rendering excellent service. In the horizontal blunger the paddles beat through the clay slip and come in forceful contact with the clay lumps, breaking them up and thereby greatly facilitating the dissolving process. It is reported that actual plant operation has proved that the time of finishing a charge has been reduced to less than one-half of the time consumed by the vertical type blunger. F.P.H.

Measuring apparatus for high temperatures. ANON. *Keramos*, **7** [10], T6; [11], T6; [12], T6 (1928).—Resistance thermometers and thermoelectric pyrometers are described. Their applications and limitations are discussed. F.P.H.

Mechanical feeders for clay. ANON. *Brit. Clayworker*, **37** [435], 137(1928).—A mechanical feeder is preferable to the average man. Such a machine supplies the clay, shale, or other material to the mills at a uniform rate with the result that a larger output is obtained and there is less wear and tear on the mill and engine and the amount of power required is usually reduced by at least 10%. The 3 chief types of auto feeders in general use are (*a*) conveyer feeders, which consist of a conveyer belt with a vertical barrier at a suitable distance above it so placed that the thickness of material on the belt is kept constant; (*b*) rotary feeders, in which the measurement and delivery of the material is effected by a rotating plate, drum or other device; (*c*) screw conveyers are excellent insofar as they require little power and are very positive in action but are difficult to adjust when different proportions of material are required. All automatic feeders work best with material which is in pieces of moderate size. R.A.H.

Disadvantages of waste heat driers. ANON. *Brit. Clayworker*, **37** [435], 152 (1928).—The advantages to be gained by using waste heat from kilns, boilers, etc., for drying brick and tile are so often mentioned that the disadvantages are easily overlooked. It is not unusual that the anticipated quantity of heat is not available, or that some of the goods are imperfectly fired because the kiln has been robbed to supply the drier with heat. When waste gases from an old kiln are delivered to a new drier by means of a fan the goods in the center of the kiln are well fired, but those near the crown are only warmed through. To obtain effective working both of a kiln and drier, it is not sufficient to connect them; the draft must be carefully regulated and care must be taken that there is enough heat in the kiln before any is taken for the drier. A common mistake to use too short a kiln, *i.e.*, with too few chambers, and also to allow the fire to travel so slowly that all the heat in the gases is absorbed by the goods. If the disadvantages of heating a drier by waste gases from the kiln are to be kept at a minimum the chief precautions required are an airtight kiln of ample length, a regular output, and so skilful a management of the kiln that an ample supply of heat to the drier is always maintained. R.A.H.

Automatic water alarm. ANON. *Mech. World*, **83** [2161], 395 (1928).—A simple form of water alarm is made by the Rotary Air Compressor Co., Ltd. E.P.R.

The deposition of alkaline earth sulphates. L. A. BHATT AND H. E. WATSON. *Jour. Indian Inst. Sci.*, **10A**, 117–29 (1927).—The behavior of $CaSO_4$, CaS, and $CaSO_3$ on heating alone and in the presence of SiO_2 has been studied at temperatures of about 1100°. The effect of adding reducing agents to the $CaSO_4$-SiO_2 mixture causes the SO_2 to be evolved at a lower temperature but the temperature for complete decomposition is higher, because of formation of CaS. A quantitative decomposition of $CaSO_4$ is obtained in laboratory experiments by heating with excess SiO_2 for 4 hrs. at 1100° in a slow current of air. SiO_2 accelerates the decomposition of $MgSO_4$ but to a less extent than $CaSO_4$. Similar experiments with $SrSO_4$ resulted in only 2.3% decomposition with 1 mol. SiO_2 in 1 hr. at 1100°. With $BaSO_4$ the decomposition was 5.4%. (*C. A.*)

Two new rotating furnaces for the laboratory. V. TAFEL. *Metall Erz*, **25**, 158–60 (1928).—Details are given for constructing two gas-fired, rotating furnaces, the tube of one being 37 cm. long and of the other 2.2 m. (*C. A.*)

Nickel electrical resistance thermometers. W. DEL REGNO. *Rend. acad. sci. Napoli*, **32** [iii], 194–201 (1926).—Pt can be replaced by Ni in electric resistance thermometers for measuring temperature differences below 500°, and for measuring temperatures directly below 360°, with a notable increase in sensitivity, Ni having a high thermal coefficient of electric resistance. The latter may be expressed by $R_t = R_0 + at + bt^2 + ct^3$, where a, b, and c are constants characteristic of the threads employed, and have the respective values in a sample examined of 3.085×10^{-3}, 7.7×10^{-7} and 1.06×10^{-8}. The oxidation of Ni is negligible below 500°, the tensile strength is higher than that of Pt, the change of resistance with temperature shows no hysteresis, and the influence of traces of impurities is, in contrast with Pt, very slight. (*C. A.*)

BOOKS

Treatise on Chemical Engineering. G. MARTIN. Crosby, Lockwood & Son, London, 1928. Price 3 guineas.—Engineering applied to the flow of industrial gases, steam, water, and liquid chemicals, and including pneumatic transport of powders and granulated materials. H.H.S.

Mechanochemistry and the Colloid Mill. P. M. TRAVIS. The Chemical Catalog Co., New York, 1928. Price $4.00.—Includes practical applications of fine dispersion. H.H.S.

PATENTS

Coating machine. CARADOC L. JONES. U. S. 1,677,453, July 17, 1928. In a spray apparatus a housing, a plurality of flexible conduits extending through the housing, a movable member in the housing and supporting the conduits therein, and manually releasable tension means on the housing and in operative connection with the movable supporting member to maintain the conduits closed by compression between the member and a portion of the housing.

Gate for leers, ovens, etc. ROBERT B. STUCKEY. U. S. 1,677,933, July 24, 1928. A gate for hardening cylinders and the like, comprising a movable gate member, means for pivotally and slidably supporting one end of the gate member and located on the inside of the cylinder, a frame for engaging the outside of the gate member, and means for drawing the gate member against the frame.

Scraper for rotary filters. ALBERT L. GENTER. U. S. 1,678,639, July 31, 1928. In a rotary continuous filter, the combination of a filter element, of scraping means therefor comprising a support, a plurality of diagonally arranged scraping wires attached to the support and conforming to the surface of the filter element, the wires being spaced apart and arranged in parallel relation and positioned to engage and remove the cake from the filter element.

Filtering device. WILLIAM M. MORRISON. U. S. 1,678,704, July 31, 1928. A filter comprising a container having a solution to be filtered therein, a plurality of filter-plates, each of said plates comprising a pair of filter surfaces separated to form a closure, means for applying a vacuum to the closure while the plates are immersed in the solution, whereby a cake may be formed in the spaces between adjacent plates, means for raising the plates from the solution, and means for applying mechanical pressure to the assembly in raised position while maintaining the vacuum, whereby a substantially dry, solid cake may be obtained.

Disk feeder. LOUIS C. BONNOT. U. S. 1,679,398, Aug. 7, 1928. A feeding apparatus including a cylindric spout having a side outlet opening in its lower peripheral portion, a movable feeding disk beneath the spout for receiving material, and a scraper

blade tangential to the spout coöperating with the movable disk to feed material over the edge.

Saggers for pottery. A. J. CAMPBELL AND MINTONS, LTD. Brit. 290,150, July 4, 1928. A frame for supporting china, earthenware, etc., articles during firing is provided with a number of rods or strips formed solely of earthenware fire clay, or other ceramic mixture and secured in spaced transverse relation across the frame. Distance pieces may be provided on each frame, and the rods may be secured by glaze, etc. The frame is formed of pottery or metal.

Kilns, Furnaces, Fuels, and Combustion

Further data on operating cost of a platinum-wound resistance furnace. EDWARD ORTON, JR., AND J. F. KREHBIEL. *Jour. Amer. Ceram. Soc.*, **11** [9], 685–86 (1928).—The results derived on the cost of operating a platinum-wound resistance furnace after one year's use, are presented.

Firing of gas and pulverized coal. F. G. CUTLER. *Blast Fur. Steel Plant*, **16** [7], 927–30 (1928).—The use of gas and pulverized coal in steam generation is considered. F.P.H.

Fuels. W. SCHUEN. *Feuerungstechnik*, **16** [3], 26–29 (1928).—The following subjects are discussed: (1) comparison of fuels according to their physical and chemical constitution, (2) diagrammatic representation of fuels and combustion products on the Gibbs triangle, (3) diagrammatic representation of the energy change during combustion on the Gibbs triangle, (4) acetylene the best fuel, (5) value of brown-coal briquets in proportion to the pressure to which they are compressed. F.P.H.

The dew-point of flue gas. W. GRAULICH. *Feuerungstechnik*, **16** [4], 37–41 (1928).—A method of calculating dew-point temperature of gases made from solid, liquid, or gaseous fuels by means of Dalton's law is described and illustrated by means of examples. F.P.H.

Automatic furnace regulator. WINTERMEYER. *Feuerungstechnik*, **16** [5], 49–52 (1928).—The development of the automatic and semi-automatic furnace regulators is traced. F.P.H.

Studies in combustion. FRITZ SCHUSTER. *Feuerungstechnik*, **16** [5], 54–56 (1928).—A general discussion is given of the principles of combustion. The value and use of the Bunte diagram in studying combustion are considered. F.P.H.

Combustion with oxygen-rich air. W. GUMZ. *Feuerungstechnik*, **16** [7], 73–76; [8], 88–90(1928).—The following subjects are considered: (1) influence of oxygen-rich air on the combustion process, (2) use of oxygen-rich air in steam boiler firing, (3) combustion calculations using air containing various amounts of oxygen, (4) heat economy in using oxygen-rich air in combustion. F.P.H.

Temperature measurements of hot flowing gas. K. M. WATSON AND O. L. KOWALKE. *Gas Age-Rec.*, **61** [16], 541–44 (1928).—The measurement of the temperature of gas flowing in a well-insulated pipe or conduit presents no unusual difficulties. If, however, the confining walls are at temperatures different from that of the gas, several types of errors may be introduced due to the interchange of heat between the measuring instrument and the walls. The mean temperatures of a gas stream in a circular pipe may be readily calculated if both the linear velocity and the temperature are known at every point in the cross-section. With this information the cross-sectional area of the pipe may be divided into a number of elements in the form of annular rings and a calculation made of the heat content of the gas passing through each element per unit time. The total heat content of the stream per unit time, above the reference temperature, is then obtained by the summation of that passing through each of the elements. The total volume of gas per unit time may be calculated in a similar way. The mean

temperature of the stream, above the reference value, is then obtained by dividing the total heat content of the stream by the product of the total volume of gas, and neglecting its variations with temperature. For ordinary work this assumption is sufficiently accurate where large temperature differences are not encountered. The specific heat of the gas then drops out of the calculations entirely and the mean temperature is represented by the summation of the products of the temperature and volume of gas passing through each element per unit time, divided by the total gas volume per unit time. The major source of error in such calculations lies in the uncertainty of the determination of both the temperature and the velocity of the gas at the walls where the cross-sectional area is the greatest and accuracy most important. In many cases it is not feasible or convenient to determine traverses in the flowing stream; in any case the necessary calculations are laborious. It is, therefore, desirable that some method of measuring directly and easily the mean temperatures be available. Such an instrument must be of an integrating type and the wire grid resistance thermometer seemed to offer the greatest possibilities. By using wire of small diameter, errors due to radiation may be minimized, while the relatively good thermal conductivity of the wire tends to equalize its temperature to a value approximating the mean. By mounting the grid in a ring thermally insulated from the pipe walls, conductance errors become negligible. Still greater accuracy may be obtained by mounting the grid in a sharp constriction or orifice. In such a case the velocity of the gas past the wires is greatly increased, thus increasing the coefficient of heat transfer and rendering radiation transfer less important. A resistance thermometer grid was constructed upon an annular ring of $^1/_4$ inch. Transite board with an inside diameter of $3^1/_2$ inches and an outside diameter of 6 inches. The resistance element was of No. 22 B.&S. gage nickel wire, strung across the supporting ring at $^1/_4$-inch intervals. The resistance was measured by means of a portable potentiometer and a standard resistance. The thermometer and standard resistance were connected in series with a rheostat and a dry cell so that a current in the neighborhood of 0.01 amperes would flow through them. The potential drop was then alternately measured across the standard resistance and the thermometer. The thermometer was calibrated, with the electrical apparatus, in an oil bath against a standard resistance thermometer. F.P.H.

Production of water gas in vertical retorts. T. F. E. RHEAD. *Gas Age-Rec.*, **61** [19], 667–68 (1928).—A steady yield of blue water gas of calorific value 285 to 290 B.t.u. gross can readily be obtained by steaming graded coke in a normal continuous vertical retort provided the correct conditions of (*a*) quantity of steam, (*b*) rate of coke extraction, (*c*) quality of coke, (*d*) size of coke, (*e*) temperature, (*f*) exhauster "pull," (*g*) gas tightness of retort, are maintained. A calorific value of 290 to 300 is frequently obtained. F.P.H.

Natural gas as an industrial fuel. FRED S. EDGREN. *Gas Age-Rec.*, **61** [20], 702–706 (1928).—The following subjects are discussed: (1) composition of natural gases found in the U. S., (2) the ignition temperatures of the consituents, (3) chemical reactions entering into the combustion of the principal constituents of natural gas, (4) combustion calculations for a typical natural gas, (5) value of flue-gas analysis, (6) calculation of flame temperatures, (7) determination of heat losses in the flue gases, (8) the nomographic chart for equivalent cost of gas and oil. F.P.H.

Electric furnaces in England. ANON. *Keramos*, **7** [8], T2 (1928).—A description is given of electric furnaces recently constructed in England for the firing of ceramic products especially glost firing. Temperature regulation, heating elements, and design of the tunnel kilns are considered. F.P.H.

Handling CO_2 in efficient firing. A. C. SCHMID. *Brick Clay Rec.*, **73** [3], 166–67 (1928).—Control of the temperature of the material being fired affects not only the final

quality of the ware but also its coloring. With the aid of a CO_2 recorder, not only is the control of temperature simplified but the efficiency of the kiln can also be increased by control of the excess air. The recorder has been of value in maintaining consistency of color by checking the condition of the atmosphere surrounding the ware under fire inside the kiln. E.J.V.

Symposium on tunnel kilns. ANON. *Brick Clay Rec.*, **73** [4], 234–37 (1928).—A report of a discussion on tunnel kilns held at the spring meeting of the American Refractories Institute. Questions asked and answered dealt with cost, fuel consumption, method of cooling, length of time maximum temperature is received by ware, adaptability for use with dry-press or stiff-mud process, labor savings, cost of repairs and maintenance, operation on different time schedules, uniformity of the product, and others of similar interest. E.J.V.

Determination of sulphur and hydrogen sulphide in coal distillation gases. R. KATTWINKEL. *Messtechnik*, **4** [2], 29–33 (1928).—A discussion of the quantities and distribution of sulphur compounds in coal distillation gases; methods of determining total sulphur in the gas (Drehschmidt, Niermyer, and Dickert methods); experimental testing of the Dickert method; methods for the determination of hydrogen sulphide; and a titration apparatus for the rapid determination of hydrogen sulphide. E.J.V

Electrical pottery firing. J. MOORE AND A. J. CAMPBELL. *Trans. Ceram. Soc.* [Eng.], **27** [1], 12–19 (1927–28).—The so-called "unit size" kiln working at the factory of Josiah Wedgwood & Son is approximately 82 ft. long, and consists of an entrance, preheating, firing and cooling zones. The placing capacity of the truck is 4 ft. 5 in. by 1 ft. 3 in. and 2 ft. high. For the area given one truck is produced every hour from the kiln, firing the highest class of enamels, gold, etc., used in fine china and fine earthenware; *i.e.*, the propulsion is at the rate of 4 ft. 6 in. per hour. This speed could be exceeded for cheaper classes of production. The cost of operating such a furnace is equivalent to twenty-one men-shifts per week, approximately 44 units of electricity per hour, and an estimated repair bill which should certainly not be greater than £2 per week. R.F.S.

Practical experience of firing refractory materials with oil. FRANK WEST. *Trans. Ceram. Soc.* [Eng.], **27** [2], 104–21 (1927–28).—In England, in normal times, oil firing is more costly than coal. During the coal stoppage in 1926, although there were good stocks of coal, W. used substitutes for firing kiln. Coal was used in the starting kilns and the firing continued with oil for the other kilns with the aid of the forward heat. This method proved very satisfactory. Oil was forced through very fine sprays or jets into the kiln after being properly screened with fine silk screens and heated. First the sprays were fixed at the ends of the kilns, two in a kiln, and although effective, the sprays were rather troublesome to keep clean, and growth of carbon occurred, particularly at the points where the oil struck the hot brickwork. Later, the sprays were fixed through the coal-firing holes on the top of the kiln and this method proved very satisfactory. Beehive kilns, 22 ft. 6 in. in diameter and 12 ft. high inside, have 11 furnaces and the firemouths of these furnaces were built in, small spaces which could be regulated being allowed for the ingress of air. Burners were placed in each furnace. The bags inside for the first experiment were made as for coal firing, but afterward these were altered and an annular space surrounding the actual setting, to serve as the combustion chamber, was arranged. Three burners placed at equal distances were used up to 26 hours and then another burner was put on. Between the 38th and 46th hours there were 5 burners working, and from the 46th to the end of the firing 7 burners were used. The total oil consumption was 11.69 T. The rate of oil consumption and rise of temperature with other data are shown as well as the comparative results of coal and oil. Oil firing on a semicontinuous kiln was also worked out. The experiments indicate that oil may

be used for firing with success when the cost of coal is prohibitive or when it is difficult to obtain. R.F.S.

Aids in firing brick and tile. ANON. *Brit. Clayworker*, **37** [434], 108–109 (1928).—Among the oldest and simplest aids to firing are Seger cones and Holdcroft's thermoscopes. These were followed by the pyrometer of which the recording type is the most valuable. Thermometers for low temperatures are advantageous. An equally important aid is the recording draft gage. The analysis of the kiln gases, which can be made almost automatic is being used extensively. R.A.H.

Spontaneous heating of coal. J. D. DAVIS AND D. A. REYNOLDS. Bur. Mines, *Tech. Paper*, No. 409, 74 pp.(1928).—Results of chemical and physical research, particularly that of most recent date, have been assembled in abstract form and critically examined. The general conclusions justified by this study are as follows: (1) All coals but anthracites undergo spontaneous heating; the liability to self-heating is greatest among coals of lowest rank. One should therefore use greater care in storing a subbituminous coal than in storing a high-rank bituminous coking coal. More pains should be taken to prevent segregation of fine coal in the storage pile, and foreign matter should be excluded more carefully. (2) Oxidation of the coal substance itself is the main cause of spontaneous combustion; some of the organic constituents may contribute more to the heating than others, but it has not been shown that any one constituent exerts a preponderant influence to the exclusion of the rest. (3) The process of spontaneous heating may be considered to take place in two stages. The first stage is operative at room temperature as soon as freshly broken coal is exposed to the air. It begins with the physical absorption of oxygen and is continued by the formation of a solid chemical compound of coal and oxygen, which is gradually decomposed as the temperature rises. Decomposition is not complete, however, until the temperature reaches about 445°F. This first stage of the process generates heat, but not as much as the second stage. The coal increases in weight by the amount of oxygen retained. The second stage involves the breaking up of the solid compound of coal with oxygen and the formation of the final oxidation products, carbon dioxide, carbon monoxide, and water. Both stages of the process go on simultaneously. There is no sharp transition from one stage to the other. The rate of heating increases logarithmically with the temperature. (4) Pyrite when finely divided can increase the tendency of a coal to heat spontaneously. One would not, therefore, select for storage a coal containing fine pyrite. (5) Opinions differ as to what effect moisture in coal has on spontaneous heating. Probably the effect of moisture is determined by the conditions of storage. If only those parts of a storage pile would be wetted where spontaneous heating would otherwise develop, it would undoubtedly be prevented; the heat required to vaporize the water would be more than the oxidizing coal could supply. Wetting down the surface of the whole pile changes the conditions of ventilation and may favor heating at points not reached by water where dangerous heating would not otherwise occur. (6) Chemical factors other than those touched upon in items (1) to (5) preceding have little or no influence on the spontaneous heating of coal. (7) Laboratory studies have indicated what kinds of coal heat the most readily, and their relative tendencies to heat can be measured by several methods. It is believed that the most fruitful studies of the future will deal with storage conditions. R.A.H.

Application of continuous-kiln principles to downdraft kiln firing. D. D. OMUNDson. *Clay Prod. News*, **1** [4], 6–8 (1928).—The economy of continuous kilns has led to heat recovery in periodic kilns. At the plant at Boischatel, O., there is a battery of nine kilns on the Minter system of downdraft kiln firing. The "hook-up" works efficiently while retaining the flexibility of individual treatment inherent in a periodic kiln. H.H.S.

A simplified and exact calculation of stack loss. H. KOLBE. *Brennstoff u. Wärmewirtschaft*, **10**, 91–98 (1928).—The constant 0.65, in the Siegert formula, $Q_{vs} = 0.65 (t_1 - t)/(k_1 + k_2)$ (in which Q_{vs} = stack loss in % of H_u, the net calorific value of the coal, t_1 and t = flue and outside temperatures and k_1 and k_2 = volume % of CO_2 and inflammables in the flue gas), does not hold for brown coal. It is therefore replaced by a variable, s, which is directly proportional to the C content of the coal and inversely to H_u. A table of values of s, for various coals and conditions, ranging from 0.654 to 1.17, sample calculations and specific heat charts are given. (*C. A.*)

Low-temperature carbonization. F. SCHWERS. *Chimie et industrie*, **19**, 583–88 (1928).—A brief description of the installations and performances of Salerni low-temperature carbonization retorts at the Gand plant of the Centrales Electriques des Flandres (in a steam-electric central power station using a high-volatile, caking coal), in the Zagreb district of Czechoslovakia (for the carbonization of a moist xyloid lignite), and at Resiutta (Frioul), northern Italy (for the treatment of highly bituminous shale), bringing out particularly the attention which must be given to apparently insignificant details in order to obtain successful and efficient operation. (*C. A.*)

Primary decomposition of coal. I. Temperature of initial decomposition. J. G. KING AND R. E. WILLGRESS. Dept. Sci. Ind. Research, Fuel Research, *Tech. Paper*, No. 16, 19 pp. (1927).—The significance of the first appearance of gases, moisture and oily products in relation to the decomposition of coal by heating is discussed in connection with an examination of previous work. Experiments were carried out by the Gray-King method using 6 fuels: peat, lignite, nonmedium- and strongly-caking bituminous coals, and anthracite. Proximate and ultimate analyses of the fuels and results of their Gray-King assay for coke and by-products at 600° are tabulated. In the latter tests 4 thin thermocouples were placed to record temperature of the furnace, at the surface of and in the center of the coal charge, and in the middle of the coal and touching the retort wall. The time-temperature curves showed considerable divergence for the first 35 min. when a temperature of 520° had been reached and all 4 thermocouples gave identical readings. Therefore, the temperatures ordinarily reported for the first appearance of oil-vapor are higher by 50° to 100° than the true temperature at which they are evolved from the coal. Further experiments were made by applying the sweeping action of purified inert gases, N, H, and CO_2 passed through a mixture of 20 g. of the fuel, crushed to pass a 10-mesh and remain on a 20-mesh (I.M.M.) sieve, and 40 g. of freshly ignited sand. A section diagram of the apparatus, methods of its operation, and for purifying the gases is given. The rate of increase in temperature was 10° per hr. and the rate of flow of sweeping gas was 9 l. per hr. which changed the gas in the distilling tube every 0.5 min. The temperature of initial decompositions, color of oil, and appearance of fumes, acids or NH_3 for all 6 different fuels using N, for the lignite and strongly caking bituminous coal using H, CO_2, and *in vacuo* are tabulated. Results in N were: peat 180°; lignite 235°; bituminous coals, strongly caking 215°; medium caking 230°; noncaking 245°. Approximately similar results were obtained using H, CO_2 and *in vacuo*. This decomposition continues for some hours at least if the coal is maintained at the initial temperature. With bituminous coals the temperature of initial decomposition appears to increase with increasing O and decreasing C contents. With the anthracite no oils appeared up to 550°, but NH_3 was evolved in quantity at about 450°. Experiments using N as the sweeping gas were made to determine at what stages during the heating of the coals water was produced. The results given and discussed indicate the evolution of water from coal in the absence of air is a gradual process probably indicative of internal oxidation. For certain coals there are temperatures at which the rate of evolution of water is accelerated; with bituminous coals the first acceleration of moisture evolution coincides with the appearance of oil

vapor. A photomicrograph of oil drops and crystals of NH_4Cl in the sublimate from the anthracite, a diagram of apparatus set up for distillation of coal *in vacuo* and a bibliography are included. (*C. A.*)

Ceramic processes with special reference to heating practice. S. R. HIND. *Fuel Econ. Rev.*, **6**, 53–65 (1927).—A review. (*C. A.*)

Power factor in high-frequency spark induction furnaces. R. DUFOUR. *J. Phys. Radium*, **8** [vi], 508–21 (1927).—A study of the schematic function of the furnace is made, based on certain hypotheses which enable a mathematical treatment of the subject to be developed, from which the time of charge of the condensers, the number of charges per sec., the intensities of the current and heat liberated at the end of the charge or discharge and eventually the power factors are calculated successively. The variation of the power factor with the tension of the spark, and the relation of the number of wave-trains per sec. to the phase-angle, are also derived. (*B.C.A.*)

Apparatus for the industrial determination of the humidity of a gas of high dew point. R. MARTIN. *Chal. et Ind.*, **8**, 649 (1927).—The apparatus consisted of a steel cylinder with taps above and below, the upper tube being connected to a manometer, the lower to the gas supply to be tested. After heating the tube to above 100°, it was filled with gas and the taps were closed. Measurement of the pressure at two different temperatures was obtained by plunging the cylinder into cold and hot water. Curves were given to allow of the graphic determination of the humidity from the results. (*J.S.G.T.*)

The use of coke-oven gas in the glass industry. STANG. *Glashütte*, **57**, 991, 1013 (1927).—Coke-oven gas was first used for firing a Martins furnace at Mülheim in 1909. For the successful combustion of coke-oven gas an air excess of 40% was required and since the gas itself could not be preheated, it was necessary to preheat the air to higher temperatures than usual. The following tables give a comparison of costs for producer and coke-oven gas firing for a works.

TABLE I

Producer Gas Firing Costs

	Coal cost (R.M.)	Wages (R.M.)	Total cost (R.M.)	Cals.	Cu. m. of gas
(1) Sheet glass tank	171,600	47,558	219,158	34,749 mill	25,740,000
(2) Flattening plant	75,799	21,496	97,295	5,822 "	4,851,000
(3) Cast glass tank	126,000	30,496	156,496	25,200 "	18,000,000
(4) Cast glass tank	126,000	27,106	153,106	25,200 "	18,000,000
Total	499,399	126,656	626,055	90,971 "	66,591,000

TABLE II

Coke-oven Gas Firing Costs

	Gas cost (R.M.)	Wages (R.M.)	Total cost (R.M.)	Cals.	Cu. m. of gas
(1) Sheet glass tank	73,360	7,560	80,920	33,012 mill	7,336,000
(2) Flattening plant	12,300	7,560	19,860	5,531 "	1,230,000
(3) Cast glass tank	53,200	7,560	60,760	23,940 "	5,320,000
(4) Cast glass tank	53,200	7,560	60,760	23,940 "	5,320,000
Total	192,060	30,240	222,300	86,423 "	19,206,000

The coke-oven gas had a heating value of 4500 cals. per cu. m. and cost 1 pfennig per cu. m. Conversion into the new conditions entailed an expenditure of 2,000,000 R.M., the interest on which at 14% was 286,000 R.M. per year. The new total expenditure was thus 222,300 + 286,000 = 508,300 R.M. as against 626,055 R.M., a saving of 117,755 R.M. per year. (*J.S.G.T.*)

BOOK

Electric Heating. EDGAR A. WILCOX. McGraw-Hill Book Co., New York, 1928. 46 pp. $5.00. Reviewed in *Min. and Met.*, 9 [259], 339 (1928).—This book is intended

to fill the present demand for published data on electric heating. It gives a general perspective of the field, tries to show that electric heating is being given the recognition it deserves, and gives data and descriptive matter for ready reference purposes. It is intended for the use of commercial executives, salesmen, and engineers engaged in creating markets for either heating apparatus or the resultant heating loads. Considerable space is allotted to the operating characteristics of various heating devices and the kind of load they create. Merits and limitations of both electric and fuel heat are considered and the processes to which either may be applied. Several chapters are devoted to fundamentals and most of the information in the other chapters has been assembled from engineering society reports, trade journals, government publications and W.'s experiences. F.P.H.

PATENTS

Leer heating means. ENOCH T. FERNGREN. U. S. 1,653,042, Dec. 20, 1927. In an annealing leer, means for supporting a sheet therein, and heating members above the sheet for directing heat along the border portions of the sheet to effect a localized heating thereof.

Updraft process of and muffle kiln for firing. THOMAS DOWNS. U. S. 1,677,818, July 17, 1928. The method of kiln drying ware in a kiln including circulating air upward about the sides and over the crown of the kiln, circulating air beneath the kiln and upward therethrough, and regulating and controlling the relative circulations about and through the kiln.

Superstructure for tunnel-kiln cars. DWIGHT BUSHNELL HENDRYX. U. S. 1,678,251, July 24, 1928. A tunnel kiln car having a superstructure comprising a course of blocks of refractory material, supported upon blocks of standard brick size.

Kilns. H. WEBSTER. Brit. 291,482, July 25, 1928. In a pottery or like kiln, of the kind having around its periphery two series of fireplaces serving to fire the kiln with updraft and downdraft respectively, only one series is in operation at a time, the gases from that series passing through the whole of the contents of the kiln. In the right-hand kiln the gases from the downdraft fireplaces pass over the bag wall and through the perforated floor into the well; the left-hand kiln shows the updraft fireplaces which alternate with those of the other series and deliver the gases upward through the floor into the kiln whence they pass downward behind the wall to an annular flue. Part of a battery of kilns is connected for continuous working, dampered flue connections being provided so that the waste gases from any kiln, whether working with updraft or downdraft, may be passed to any other kiln or kilns of the series or to driers, etc. The gases from the right-hand downdraft kiln pass from the well through an opening into a longitudinal flue running the whole length of the battery and fitted with dampers by suitable manipulation of which the gases may be caused to pass in either direction and upward into the adjacent kiln. If the dampers between the kilns be closed, the gases pass from the flue into the cross-flues from which, by operating suitable dampers, they can be caused to pass direct to a chimney into a flue and thence to any kiln of the series, or into a waste-gas flue leading to driers or other waste-heat utilizing apparatus. Similarly, the waste gases from a kiln working with updraft pass from the flue of that kiln through a connection to the flue of the adjacent kiln from which they pass into the longitudinal flue and thence directly to the next kiln or into the cross-flues as desired. The invention is also applicable to muffle-heated kilns for firing terra cotta or other ware with which contact of combustion gases is not desirable.

Tunnel kilns. L. MELLERSH-JACKSON. Brit. 291,504, July 25, 1928. In a tunnel kiln for use in the manufacture of ceramic ware, the muffle has heating-flues on all sides,

and is formed with a floor lining of vitreous material, in direct contact with which move carrier slabs for the ware. The slabs are preferably made of Carborundum, and friction between the slabs and the floor may be reduced by silica sand or powdered quartz. In the double kiln, each muffle is supported by a solid wall and pillars and is heated by a series of burners delivering into the space beneath the floor. Transverse walls in the preheating-zone prevent intermixture of the gases from the different burners until they reach the flue space between the muffles, and separate outlet connections for the gases from the main heating and preheating zones are provided. In the main heating-zone both the muffles and the side and top flue spaces are made wider than in the preheating-zone. Passageways giving access to the muffle are formed by tubular housings extending across the flue space and connecting registering apertures in the muffle and outer walls. An apparatus for moving the ware-carrying slabs through the muffle comprises a ram driven from a power shaft through worm gearing, a clutch, pinions, and a rack. When the clutch is disengaged the ram can be withdrawn quickly by operation of the hand wheel.

Furnaces. H. A. PROCTER. Brit. 291,570, July 25, 1928. A tunnel annealing furnace is heated by burning pulverulent fuel in chambers separate from, but communicating with, the tunnel chamber. The combustion chambers may be at the sides of the tunnel, or at the top or ends, having baffles arranged to cause heating-gases to take a zig-zag path. A large combustion chamber may be divided into a number of independently fired sections. Overheating of the walls is prevented by the circulation of air or water through vertical pipes connected at their upper and lower ends to headers. The walls include horizontal plates having apertures for the pipes and up or down turned tongues which form spaces for bricks. Air for combustion may be heated in passages in the walls.

Geology

Mineral constituents and origin of kaolin deposit near Spokane, Washington. G. E. GOODSPEED AND A. A. WEYMOUTH. *Jour. Amer. Ceram. Soc.*, **11** [9], 687–95 (1928).—This paper discusses petrographic and mineralogic features of kaolinite and associated minerals from a certain kaolin deposit near Spokane, Wash. Here the kaolin occurs in dikes, veinlets cutting a sandy material, and has field relations and mineral associations that are not in harmony with the usual conception of residual deposits due to weathering. The evidence points strongly to endomorphic action or perhaps even direct primary origin from highly aqueous magmatic solutions.

Flotation of fluorspar ores for acid spar. WILL H. COGHILL AND O. W. GREEMAN. Bur. Mines, *Report of Invest.*, Serial No. 2877, June, 1928.—The supply of gravel spar and acid spar is not well balanced. Gravel spar (85% fluorspar, 5% silica) gluts the market, whereas acid spar (98% fluorspar, 1% silica) is somewhat scarce. Hence it is desirable to convert some of the gravel spar into acid spar. Although studies were made of gravity concentration and decrepitation by heat treatment as well as flotation of ores the report relates only to flotation. The results of one of the flotation runs is appended, together with a list of the reagents used. A discussion follows on the yields afforded from samples of certain spar content and some of the difficulties encountered with the specific sample chosen. R.A.H.

Association of water with serpentine. P. G. NUTTING. *Jour. Wash. Acad. Sci.*, **18** [4], 81 (1928).—Experimental evidence points to the fact that water exists in raw serpentine in three distinct forms, adsorbed, monohydric, and dihydric. The weight temperature curve does not show this. At the lower transition point (368°C) the indicated water content is 14.90%, or 2.003 in molecular proportion. At the higher point (620°) the water content is 9.26%, corresponding to 1.25 molecules instead of

one molecule. It is rather remarkable that the specific energy of dehydration should be independent of temperature for adsorbed water as well as for molecular water.
A.J.M.

A spiral graph of geologic time. D. WHITE. *Jour. Wash. Acad. Sci.*, **18** [8], 201 (1928).—Partial unwinding of a closely coiled spiral forms the basis of the picture. The origin and earliest history of the earth is represented by the obscure coils in the center. As the spiral opens, the historical record becomes more distinct. Recent time is very brief and evolution is still going on. A scale of years may be adopted for the spiral.
A.J.M.

Studies of clays. C. S. Ross. *Jour. Wash. Acad. Sci.*, **18** [9], 265 (1928).—The work thus far indicates that the important clay-forming minerals are not large in number, and that a large proportion of those formerly described are not valid mineral species. The clays may be divided into 3 main groups. (1) The kaolin group includes kaolinite, halloysite, and macroscopically crystalline form of halloysite. These have moderate indices of refraction, low birefringence, and good crystals are not rare. (2) The montmorillonite group contains montmorillonite, beidellite, nontronite, the iron-bearing member of a beidellite-nontronite series, and two unnamed members of the group. The members of this group are hydrous aluminum silicates with variable proportions of MgO and CaO, and of Fe_2O_3 which replaces Al_2O_3. The ratios of silica to alumina vary from 2:1 to 5:1. (3) A group of potash-bearing clays has been found but its study is in preliminary stages. The above is from R.'s abstract which alone is given under the reference cited.
A.J.M.

Contributions to determinative mineralogy. P. C. PUTNAM, E. J. ROBERTS, AND D. H. SELCHOW. *Amer. Jour. Sci.*, **15** [90], 455–60 (1928).—A description is given of the microchemical tests for the elements.
F.P.H.

Optical properties of the humite group. ESPER S. LARSEN. *Amer. Mineral.*, **13** [7], 354–59 (1928).—An attempt to correlate the chemical composition with the optical constants is disappointing. One would expect a simple and systematic relation in which the indices of refraction increase with the iron and titanium content and decrease with the increase in fluorine. There appears to be some tendency in this direction as indicated by the Nordmark minerals which are high in iron and have high indices of refraction but the relations are far from simple. While for the analyzed chondrodites the optical data are rather uniform ($\beta = 1.616$ to 1.622) although there is considerable variation in chemical composition (FeO + MnO = 2.64 to 6.62) the Tilly Foster mineral shows very nearly the chemical composition of the Kaveltorp mineral described by Penfield and Howe, yet its indices of refraction are much higher (for Kaveltorp $\beta = 1.620$, for Tilly Foster $\beta = 1.645$).
F.P.H.

Zircon from North Burgess, Ontario. CHARLES PALACHE AND H. V. ELLSWORTH. *Amer. Mineral.*, **13** [7], 384–91 (1928).—Zircon crystals from Burgess, Ontario, are characterized by unusual brilliancy; by extraordinary constancy of angles, corresponding faces on any one crystal never varying in position by more than one minute; by larger angles than hitherto recorded for the species, the polar angles of all forms being from five to six minutes larger than the accepted values; these angles lead to an axial ratio of $a:c = 1:.6429$. The angles are increased by about one minute after heating to redness, a temperature which changes the red color to pure white. It is uniaxial, with the refractive indices of "normal zircon" and the indices are slightly lower after heating. The specific gravity, 4.646 to 4.658 is increased by heating to 4.659 to 4.667. Analysis shows it to be very pure zirconium silicate with an inconsiderable content of hafnium. The abnormal angles cannot therefore be assigned to the presence of the latter element and are unexplained. Analysis of zircon: SiO_2 32.51%, ZrO_2 67.02%, CaO 0.22%, MgO 0.01%, rare earths 0.04%, Fe_2O_3 0.08%, Al_2O_3, etc. 0.21%, ignition 0.03%.
F.P.H.

Change of names of mineral localities in Europe. F. SLAVIK AND L. J. SPENCER. (Meeting Mineralog. Soc., June 12) *Chem. and Ind.*, **47**, 722 (1928).—Many important mining districts in the former Austro-Hungarian Monarchy, *e.g.*, Zettlitz, are now in other countries, and their names have been changed. Lists of changes are given, with equivalents in 15 languages, together with a statement of the principal minerals from each locality. A key to pronunciation and a glossary of geographical terms are added. H.H.S.

New mineral names. L. J. SPENCER. (Meeting Mineralog. Soc., June 12) *Chem. and Ind.*, **47**, 722 (1928).—The first list of this series was published in 1897 and gave all the names of minerals not in the 6th edition of Dana's "System of Mineralogy" (1892). Other lists have appeared every 3 years at the end of each volume of the *Mineralogical Magazine*. The new list contains about 170 names. H.H.S.

Titanium ore in Australia. ANON. *Chem. and Ind.*, **47**, 725 (1928).—A substantial deposit of ilmenite, assaying 45.9% TiO_2, is reported to have been discovered within 40 miles of Melbourne. The yearly world output of Ti ore is 12,000 T., of which 5000 T. comes from the U. S., and 4000 from Norway. H.H.S.

Chilean nitrate industry. ANON. *Chem. and Ind.*, **47**, 807 (1928).—The Chilean government has concluded that it is necessary to improve the competitive power of natural nitrate against its synthetic substitutes, and will subsidize Chilean producers to the extent of any lowering of price by the German Stickstoff Syndikat. After the Germans announce their new scale, nitrate producers will sell at firm prices, no longer subject to reduction. H.H.S.

BOOKS

Diatomaceous Earth of the British Empire and Foreign Countries. Imperial Institute. 55 pages London: H. M. Stationery Office, 1928. Price one shilling. H.H.S.

Tables for General and Special Mineralogy. PAUL NIGGLI. Gebruder Borntraeger, Berlin, Germany (1927), xvi+300 pp., 228 figs. 17 x 25 cm. Price, bound, 9.3 M. ($2.25). Reviewed in *Jour. Amer. Chem. Soc.*, **50** [3], 932 (1928). R.J.P.

Crystallographic Tables for the Determination of Minerals. VICTOR GOLDSCHMIDT AND SAMUEL G. GORDON. The Academy of Natural Sciences, Special Pub., No. 2, Philadelphia. 70 pp. Price $1.50. (*C. A.*)

Chemistry and Physics

Absolute methods in reflectometry. H. J. MCNICHOLAS. Bur. Stand., *Jour Research*, **1** [1], 29–73 (1928).—The theory and use of the integrating sphere in 3 methods of reflectometry, as proposed by Sharp and Little, Karrer, and Taylor, respectively are discussed in connection with a new absolute method in reflectometry involving no direct use of an integrating device. The new method is based upon a general law of reciprocity, first stated by Helmholtz, by means of which certain reciprocal relations between the reflective properties for unidirectional and diffused illumination are derived and applied in the method. Under completely diffused illumination the brightness of a sample, in general, increases with increasing angle of observation from the normal to its surface. The illumination on the sample being known, these brightness data are shown to yield (with the aid of the reciprocity law) the reflectance of the sample (ratio of total reflected to total incident light) for any manner of illumination ranging from unidirectional to completely diffused. Equipment is described for the measurements of reflective properties of materials under either completely diffused or unidirectional illumination for various directions of observation. The samples used include various kinds ofmaterials chosen to cover a wide range of reflectance and to represent various degrees of departure from the perfect diffusor. Comparative measurements by all the methods studied are made on these samples. R.A.H.

Interferometer measurements of wave lengths in the vacuum arc spectra of titanium and other elements. C. C. KIESS. Bur. Stand., *Jour. Research*, **1** [1], 75–90 (1928).—Wave-length determination by means of the Fabry-Perot interferometer has been made for the vacuum arc spectrum of titanium. More than 300 lines have been measured between 6743A in the red and 2941A in the ultra-violet. For many of the lines the accuracy of measurement exceeds 1 part in 6,000,000; for the majority it exceeds 1 part in 4,500,000. Using only the wave numbers of lines of wave lengths longer than 4700A, and constant wave-number differences as determined in various parts of the spectrum a set of terms has been derived, which has been used to calculate the wave lengths of the blue and violet lines. The comparison of calculated with observed wave lengths indicates that no difference in scale exists between the red and violet regions. In addition to titanium some wave lengths were measured for iron, copper, calcium, barium and other elements. R.A.H.

Analysis of bauxite and refractories of high alumina content. G. E. F. LUNDELL AND J. I. HOFFMAN. Bur. Stand., *Jour. Research*, **1** [1], 91–104 (1928).—A study has been made of the analytical details involved in the analysis of bauxite and fired refractories of high alumina content. The work has shown that an accurate analysis of these materials is a far more difficult problem than it is ordinarily thought to be. In spite of the fact that the determination of alumina is usually regarded as very simple, extreme values of 54.84 and 56.68% were reported by the analysts who coöperated on the analysis of the Bureau's standard sample of bauxite No. 69 (actual Al_2O_3 55.06%). The results for alumina and silica reported in the analysis of the standard fired refractories Nos. 76, 77, and 78 were even less satisfactory. The improper drying of bauxite and the difficulty of putting fired refractories into complete solution were found to be sources of error. Other sources of error, such as improper ignition of precipitates of aluminum hydroxide, misleading corrections for impurities derived from reagents, etc., are pointed out. An umpire method is given for the determination of silica, alumina, phosphorous, chromium, vanadium, iron, titanium, zirconium, calcium, and magnesium all as oxides. In this method the solution of the sample is divided into 3 aliquots, the compounds in two aliquots being precipitated by either ammonium or cupferron, and in the third aliquot phosphorous is determined. The alumina is then found by difference. R.A.H.

Drying clay under definite conditions. III. Relation between drying rate and air conditions. R. S. TROOP AND F. WHEELER. *Trans. Ceram. Soc.* [Eng.], **26** [4], 261–75 (1926–27).—The drying of clay takes place by the evaporation of water from the exposed surface of the clay into the air, this surface being constantly fed by diffusion of water from the inside of the clay along the fine pores of the clay structure. In the early stages of drying most of the pores, which extend in all directions, will be filled with water. The study of the relation between the drying rate of clay and the air conditions is similar to that of the relation between rate of evaporation from a water surface and air conditions. The motive force causing evaporation from the clay surface should be similar to that from water; thus the rate of drying from a clay surface should be dependent on the difference between the saturation vapor pressure at the temperature of the clay surface and the actual vapor pressure in the air in contact with the surface. The results of a series of experiments to determine the rate of drying of clay at different temperatures (30 to 80°C) and relative humidities (50 to 90%) are reported. Some of the factors involved in the evaporation of water such as temperature, humidity, and velocity are discussed and applied to the results obtained for clay drying. With Stourbridge fire clay, it is shown that during the first stage of drying, the rate of drying approximates that to be expected from water evaporating under the same conditions, *i.e.*, dew-point of the air, temperature of surface, and air movement, until the internal movement of the water in the clay begins to control the rate of drying. The information necessary

for the fuller understanding of the factors involved in drying is discussed. For parts I and II see *Ceram. Abs.*, **7** [5], 308 (1928). R.F.S.

Chemical composition of clays. A. F. JOSEPH. *Trans. Ceram. Soc.* [Eng.], **27** [1], 1–5 (1927–28).—Results of investigation have shown that there is a close relationship between the chemical composition of the "clay" and its physical properties which can be generalized by the statement that the molecular ratio of silica to alumina is related to claylike properties. The higher the ratio the more highly developed are such properties as imbibitional power for water, heat of wetting, shrinkage, tensile strength and absorptive power for vapors and dyes; with low values of this ratio, claylike properties are exhibited to only a small degree and it appears likely that with a ratio of 2.0 (the ratio for kaolinite $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) they would be entirely absent. Results also show that the colloid content of a raw material may be taken as identical with its "clay" content. R.F.S.

Three fundamental principles of ceramics. H. H. STEPHENSON. *Trans. Ceram. Soc.* [Eng.], **27** [1], 21–22 (1927–28). See also *Jour. Amer. Ceram. Soc.*, **10** [11], 924 (1927); *Ceram. Abs.*, **6** [12], 591 (1927). R.F.S.

Effect of heat on crystalline break-up of kaolin. J. F. HYSLOP AND H. P. ROOKSBY. *Trans. Ceram. Soc.* [Eng.], **27** [2], 93–96 (1927–28).—The data here presented are a continuation of former work (*ibid.*, **24,** 402 (1924–25)) and are the result of more detailed examination of the changes which occur when kaolin is heated above 600°C. The conclusion previously recorded, based on X-ray evidence, was that kaolin completely breaks down at about 600°C, forming a silicate which is stable to about 900°C. Further work confirms this, but shows that the changes which begin at 870°C are complex reactions. Samples of kaolin were heated in an expansion apparatus. Dilatation changes were recorded and the furnace was switched off at the points indicated by letters on the curve. When cold, portions of the specimens were powdered and X-ray photographs were taken, using Cu K-radiation. The results of these X-ray examinations show the following: that kaolin at 550°C breaks down to a crystalline phase, α, which is stable to 870°C; that the 870°C critical point is associated with the break-up of the α phase and with the appearance of two phases, β, and another, which is either sillimanite or mullite (until further evidence is obtained it is assumed to be mullite); that the 1060°C critical point is associated with the disappearance of the β phase which presumably breaks down to mullite plus silica; that further heating shows the complete disappearance of β, and the mullite becomes well defined. The crystalline break-up of kaolin can tentatively be summarized thus: (1) <550°C, kaolin stable; (2) 550 to 870°C, α stable; (3) 870 to 990°C, α disappearing, β and mullite forming; (4) 990 to 1060°C, β and mullite stable; (5) >1060°C, β disappearing; mullite stable. R.F.S.

Light permeability of iron and bismuth thiocyanate solutions in regard to the determination of iron in red lead. H. HEINRICHS. *Glastech. Ber.*, **5** [8], 351–54 (1927).—A study of the light permeability of solutions of iron thiocyanate and bismuth thiocyanate and mixtures of the two were made. Spectrographs of the various solutions were made and curves plotted for the light permeability. It is possible to make a colorimetric determination of the iron in red lead by converting it to iron thiocyanate in solution and using data obtained on the light permeability of the solutions. This is a method to use in determining very small amounts of iron. E.J.V.

X-ray methods of investigation. C. GOTTFRIED. *Glastech. Ber.*, **6** [4], 177–83 (1928).—There are three X-ray methods of investigation: (1) the Laue method, (2) the Debye-Scherrer method, and (3) the turning crystal method. The Laue method consists in passing white X-ray light, present in damped spectra (*i.e.*, X-ray light of different wave lengths), through a crystal in a certain direction oriented crystallographically. On a photographic plate placed behind the crystal, the X-rays reflected from the most

varied lattice planes of the penetrated crystal, produce black spots. The reflection of the X-ray light at the individual lattice planes takes place only when the equation $n\lambda = 2d \sin \delta$ is fulfilled. In this equation λ is the wave length of the reflected light, d the lattice plane interval, and δ the so-called reflecting angle, *i.e.*, the angle between the incident ray and the lattice plane in question. Therefore, reflection takes place only with an absolutely determined position of the individual lattice planes to the incident ray. The Laue method has the advantage that from the reflected picture on the photographic plate one may draw a conclusion as to the symmetry of the irradiated crystal in the direction of the radiation. In contrast with the Laue method, the second and third methods use monochromatic X-ray light, *i.e.*, light of only one wave length. While in the rotating crystal method well-developed crystals must be available, the advantage of the Debye-Scherrer method lies in the use of crystal powder. The powder to be studied is pressed into the form of a small rod or filled in a thin-walled glass capillary, and is subjected to X-ray light. On a photographic plate placed behind the preparation, or on a film placed cylindrically about the preparation, the interferences are recorded. The powder preparation, however, consists of unarranged accumulations of crystals which have all possible positions. On turning the preparation, some lattice planes (assuming sufficient fineness of the powder) always are in a position capable of reflecting, *i.e.*, the condition $n\lambda = 2d \sin \delta$ is fulfilled. On the photographic plate the totality of the reflections appear as interference circles concentric to the primary spot, while the interference bands on the film in general trace a conical shell and a cylindrical surface; only the interference rays deflected less than 90 appear as straight lines. The essence of the third method, the rotating crystal method, consists in illuminating a well-developed crystal in a certain crystallographically oriented direction, and the reflected rays are recorded on a cylindrical film whose axis is perpendicular to the incident ray. All interference points are arranged in a system of straight lines, of which one (called the equator) divided the entire picture into two symmetrical halves, while the others above and below are parallel to it at certain distances. By simple calculation from the magnitude of this distance, one can determine the magnitude of the identity period on the turning axis in Angströms. By turning about the different axial directions, one obtains the length of edges and dimensions of the elementary body. E.J.V.

Microscopy by reflected light. F. HAUSER. *Messtechnik*, **4** [1], 9–13 (1928).—Some of the subjects taken up include: new frames for the Lieberkuhn mirror; a Lieberkuhn mirror after the principle of the Mangin mirror; oil immersions in glass with arrangements for external illumination; dark field reflector for external illumination; innovations in vertical illuminators; instruments for observation by reflected and transmitted light; standard oculars for metal microscopes; a crossholder for opaque objects with inclined supporting surfaces; and a microprojector for the measurement of the ball impression in the Brinell hardness test. E.J.V.

Colloids and clay in the Sudan. ANON. *Chem. and Ind.*, **47**, 764 (1928).—In a study of soil colloids, the properties of heat of wetting and of base exchange, which had been used to estimate the colloidal content, have been found to be possessed also by the noncolloidal materials, thereby causing anomalies. Other investigations were concerned with flocculation, the osmotic pressure of clay suspensions, the action of alkalis on clay and silica, the properties of soils containing various bases, the effect of leaching, the effect of sulphur on alkaline soils, the vertical movement of salts under irrigation, and the effect of gypsum on permeability. H.H.S.

The deformation of granular solids. P. G. NUTTING. *Jour. Wash. Acad. Sci.*, **18** [5], 123 (1928).—Theoretical mechanics has suffered from the lack of a function capable of representing the deformation of bodies possessing elastic, plastic, and viscous properties all at the same time. The following equation has been developed: $s = \log$

$(1+s)=aFt$, where s is the shear, F, force per unit area, t, time, and a, a constant which is the reciprocal of the viscosity. The initial curved portion of the graph has been attributed to plastic properties and the straight line portion to true viscous flow. Evidently a smooth continuous function may represent both. A.J.M.

Revision of the atomic weight of titanium. III. The analysis of titanium tetrabromide. G. P. BAXTER AND A. Q. BUTLER. *Jour. Amer. Chem. Soc.*, **50** [2], 408–15 (1928).—Previous work on the purification and analysis of titanium tetrachloride indicated that the atomic weight of titanium was 47.90 rather than 48.1 which has been in use for some time. The present work consisted in the preparation, purification, and analysis of titanium tetrabromide. The analysis of the purified titanium tetrabromide agrees with that of titanium tetrachloride in yielding the value 47.90 for the atomic weight of titanium. R.J.P.

Thirty-fourth annual report of the Committee on Atomic Weights (1928). G. P. BAXTER. *Jour. Amer. Chem. Soc.*, **50** [3], 603–17 (1928).—The report contains a review of the work published during 1927 on the revision of atomic weights. In the table of atomic weights for 1928 contained in the report (and for which B. assumes sole responsibility), changes for the following elements have been made, helium, argon, dysprosium, neon, and yttrium. The atomic weight of potassium seems to be in some doubt, but the evidence was not sufficient to influence a change in its value in the table. R.J.P.

The adsorption of organic compounds on hydrous oxides and fullers' earth. DONALD P. GRETTIE AND ROGER J. WILLIAMS. *Jour. Amer. Chem. Soc.*, **50** [3], 668–72 (1928).—The extent to which 18 pure organic compounds are adsorbed from 0.01 M solutions on the hydrous oxides of silicon, aluminum, and iron, and on fullers' earth has been determined. Most of the organic compounds are of biological importance. It was found that the extent of the adsorption on silica of the compounds used was roughly proportional to their basic strengths, and roughly proportional to their acidic strengths in the case of adsorption on alumina. Adsorption by hydrous iron oxide was very irregular possibly due to impurities on the adsorbent. The extent of adsorption by fullers' earth was somewhat similar to the adsorption by silica, but in a few cases there was no parallel. R.J.P.

J. Lawrence Smith method for the analysis of samarskite. ROGER C. WELLS. *Jour. Amer. Chem. Soc.*, **50** [4], 1017–22 (1928).—The mineral samarskite and several closely related species have long been known to offer analytical problems quite different from those met in the analysis of silicates. A study of the J. Lawrence Smith method of analyzing samarskite was made, showing how the different elements distribute themselves in the treatment with hydrofluoric acid. Precautions to be observed in completing the different determinations are given. R.J.P.

Measuring the billionth of an inch. ANON. *Mech. World*, **83** [2157], 323 (1928); for abstract see *Ceram. Abs.*, **7** [3], 190 (1928). E.P.R.

Early experiments on ultra-filtration. EMIL HATSCHEK. *Nature*, **120**, 515 (1927).—Wilibald Schmidt (*Ann. Phys. Chem.*, **99**, 337 (1856)) proved that an animal membrane is much less permeable to colloids than to sugar and salts. This paper antidates Graham's papers on dialysis five or six years but seems to have been overlooked by historians of colloid chemistry. C.R.A.

Liquid silicate immiscibility in the laboratory and in the rocks of Agate Point, Ontario. J. W. GREIG. *Amer. Jour. Sci.*, **15** [89], 375–402 (1928).—In a recent communication T. L. Tanton has offered some criticism of G.'s paper on immiscibility in silicate melts. Tanton has drawn an analogy between what he considers the laboratory evidence for immiscibility and the evidence which he has presented for immiscibility in the case of the rocks of Agate Point and apparently concluded that they are on a par. An outline of the laboratory proof of immiscibility has been presented. All of

the points which Tanton has advanced as proof of immiscibility have been examined and found either to lead to a quite different conclusion or to have no basis in fact. F.P.H.

Plasticity of clay. A. SIMON AND W. VETTER. *Ber. deut. keram. Ges.*, **9** [4], 216–28 (1928).—The equilibrium between water vapor and clay at various pressures of water was studied. The apparatus used was that described by Zsigmondy and Bachmann (*Zeit. f. anorg. Chem.*, **75**, 189) and improved by Simon and Pohlman (*ibid.*, **149**, 101 (1926)). The pressure of the water vapor was varied by using aqueous sulphuric acid solutions of various concentrations. Isotherms were obtained from the three clays investigated at various temperatures from 12 to 250°C. The course of the dehydration curves is explained in this manner, that in the main up to about 80°C the water contained in the capillaries and the osmotically combined water is given off, but that from here on the existence field of stoichiometric compounds enters. The sharp appearance of this field is obliterated by the residual emptying of the very small capillaries. The clays investigated are probably a mixture of substances predominantly colloidal and only in small part of a stoichiometric character. F.P.H.

Investigation of the system SiO_2. I. Dilatometric measurements on tridymite and cristobalite. C. J. VAN NIEUWENBURG AND H. J. ZIJLSTRA. *Ber. deut. keram. Ges.*, **9** [4], 228–32 (1928); for abstract see *Ceram. Abs.*, **7** [7], 457 (1928). F.P.H.

New carbon dioxide analyzer. ANON. *Ceram. Ind.*, **11** [2], 194–96 (1928).—The importance of measuring the carbon dioxide content of gases within a kiln has long been realized due to the large savings possible by installing instruments capable of producing records of these gases. The exact movement of firing can thus be plotted and steps taken toward considerably reducing firing costs and also for predetermining results to effect duplication of pattern. Charles Engelhard, Inc., has developed a new gas-analysis instrument which is simple, rugged, and dependable at all times. Many of the incorporated features have been developed from suggestions offered by operative ceramic engineers. The gas-analysis unit consists of two platinum spirals wound on a fused quartz rod and inclosed in a quartz jacket making perfect mechanical protection to the platinum. It utilizes the Wheatstone bridge method of measurement. The outstanding features are simplicity, perfect drying and filtering of the gases before analysis, low cost of maintenance, and perfect mechanical protection of the platinum resistance spirals of the bridge. The spirals are completely encased in quartz which affords perfect mechanical protection and also prevents the gases from coming in direct contact with the platinum wire. This arrangement prevents the instrument from getting out of calibration, which is certain to occur if any foreign matter or corrosion exists on the platinum or heating element. F.P.H.

Formation and determination of nitric oxide in the analysis of gases. E. RICHARDS. *Feuerungstechnik*, **16** [2], 17–18 (1928).—A method for the determination of nitric oxide formed in the usual methods of gas analysis is described. F.P.H.

Devitrification and its role in ceramic technology. R. JAGER. *Keramos*, **7** [8], T4 (1928).—The crystalline and amorphous states are discussed. Conditions influencing the crystallization of melts and the importance of crystallization are considered. F.P.H.

Apparatus of the measurement of size of grains of powder. R. LORENZ. *Keramos*, **7** [9], T6 (1928); for abstract see *Ceram. Abs.*, **7** [6], 409 (1928). F.P.H.

Influence of physical and chemical factors on thermal properties of ceramic materials. WILLI M. COHN. *Keramos*, **7** [11], T5; [12], T5 (1928); *Jour. Amer. Ceram. Soc.*, **11** [5], 296–306 (1928); *Ceram. Abs.*, **7** [6], 403 (1928). F.P.H.

Constant volume pycnometer for specific gravity determinations. H. V. ELLSWORTH. *Mineral. Mag.*, **21** [120], 431–35 (1928). F.P.H.

Dependence of surface tension on the electric charge. E. BOGOSLOVSKI. *Ann. Physik*, **48** [4], 323–26 (1927); *cf.*, Ruff, Niese, and Thomas, *Ceram. Abs.*, **7** [7], 492 (1928). (*C. A.*)

Rapid determination of chromium in lead chromate pigments. G. SIROIS. *Chemist-Analyst*, **17,** 10 (1928).—Boil 0.2 to 0.5 g. of pigment with 20cc. of concentrated HCl, dilute to 60cc. with hot water, boil 5 minutes, and filter off any insoluble residue. Make barely alkaline with NH_4OH and add HCl until $Pb(OH)_2$ is dissolved; dilute to 300cc. and add 3g. of Na_2O_2. Boil 20 minutes to convert all Cr to chromate and destroy excess peroxide. Make acid with HCl, adding 5cc. in excess. Cool quickly to 85°, add 10cc. of 20% KI and titrate immediately with $Na_2S_2O_3$. At 85° there should be no precipitation of PbI_2 but the titration must proceed rapidly or there will be loss of I_2 at this temperature. (*C. A.*)

New porcelain filter with perforated bottom that may be heated or cooled. ANON. *Chem.-Zgt.*, **52,** 131 (1928).—A Büchner funnel with double walls and with heating tubes inclosed in the perforated bottom is described. (*C. A.*)

A new suction flask for quantitative analysis. G. W. KÜHL. *Chem.-Ztg.*, **52,** 131 (1928).—The body is round, with a discharge cock on the bottom. (*C. A.*)

Recovery and sinking-in or piling-up of material in the Brinell test, and effects of these factors on correlation of the Brinell with other hardness tests. A. L. NORBURY AND T. SAMUEL. *Iron and Steel Inst.*, advance copy, 15 pp., May (1928).—Measurements have been made of the "sinking-in" or "piling-up" and "flattening" and elastic recovery of 10 mm.-ball Brinell impressions on vulcanite and a number of metals in different conditions. If expressed as a percentage of the measured depth of impression, the sinking-in or piling-up of the material round Brinell impressions has a constant value for a given material, irrespective of the size of the impression. In cast materials the sinking-in, if expressed as above, may be as much as 30%, while in cold-worked materials the piling-up may reach this value. Therefore depth indicators measuring the depth from the original surface may give differences of ±30% if the hardness be calculated from the indicated depths instead of from the diameter. The effects of these phenomena on the correlation of Brinell tests with scleroscope, pendulum, and cone indentation tests are discussed. (*B.C.A.*)

Determination of iron and aluminum in the presence of calcium, magnesium, and phosphoric acid. A. J. PATTEN AND O. B. WINTER. *J. Assn. Official Agr. Chem.*, **11,** 202–208 (1928).—Further data are given confirming previous conclusions and showing that: Fe^{+++} and Al phosphates are precipitated from solutions below p_H 5.3, while Ca is not precipitated below p_H of about 6.5; NH_4OAc is a suitable buffer for keeping the reaction of the solution within the range necessary for separating Fe^{+++} and Al phosphates from $Ca_3(PO_4)_2$; Fe^{+++} and Al can be completely precipitated as phosphates; when Fe is determined as phosphate the results are slightly high, but the increase is practically within the experimental error; Fe^{+++} and Al phosphates are slightly soluble in hot 5% NH_4NO_3, but when washed 10 times the loss is practically compensated by the slight increase in the weight of the $FePO_4$. The microchemical method for determination of Al in blood described by Mull, Morrison, and Myers (*C. A.*, **21,** 2908) is being developed for the determination of small quantities of both Fe and Al. (*C. A.*)

Demonstration of a method of measuring particle sizes in ground powders. J. V. RAMSDEN. *Jour. Oil Colour Chem. Assn.*, **11,** 16–17 (1928).—A small quantity of the sample is mixed with water until a slight turbidity is obtained, and then poured into a transparent-bottomed dish made of xylonite. This dish is placed on the stage of an inverted microscope, specially designed for this work. By means of a $^1/_4$-in. microscope objective, the image of the particles is projected on a ground-glass screen on which

are ruled lines. These lines are set apart at a distance corresponding to a satisfactory mesh size for the particles. Should a particle be larger than the distance between 2 lines, the material is condemned. The instrument is in daily use for control testing of barytes. (*C. A.*)

Uniform notation and formulas for the mathematical comprehension of ore-dressing. H. MADEL. *Metall u. Erz*, **25**, 77–82 (1928).—A summary of formulas used in ore dressing, with a uniform notation, compiled by the professional committee of the *Gesellschaft deutscher Metallhütten- und Bergleute*. These are explained by M. (*C. A.*)

Advances in the preparation of colloidal solutions of metalloids and compounds and a survey of protective colloids and procedures for purification of colloids. J. REITSTÖTTER. *Oester Chem.-Ztg.*, **31**, 47–51 (1928).—A table is given containing a list of 43 protective colloids and the sols for whose preparation each protective colloid is especially suited. References to the original literature are given. (*C. A.*)

Constitution of clay-mud. H. CHATLEY. *Proc. Inst. Civil Eng.*, (London), No. 52, pp. 3–15 (1927).—The characteristic physical properties of clay as compared with wet sand of similar composition, considerable tensile strength and apparent cohesion, also its impenetrability to water, are the consequence of the fineness of the particles which renders molecular forces important. The properties are best shown when there is a sufficiency of colloid particles to cover and cement the larger ones. Terzaghi's theory of clay structure is discussed. C. has investigated quantitatively the settling of clay particles from a fresh-water suspension by addition of sea salt, a phenomenon due to the neutralization of the charges on the colloid particles by the adsorption of oppositely charged ions. Sea salt was 3 times as effective as pure NaCl in producing coagulation, this being due to the effect of bivalent Ca and Mg ions. Alum is more than 10 times as effective as salt. There is an optimum concentration of electrolyte for a given colloid concentration, as reversal of the charge takes place with an excess. (*C. A.*)

Studies of the system: Na_2O–BaO–SiO_2–CO_2. I. Reactions between Na_2CO_3, $BaCO_3$, and SiO_2 in the solid state. H. F. KRAUSE AND W. WEYL. *Z. anorg. allgem. Chem.*, **163**, 355–66 (1927).—The authors studied the reactivity of powdered quartz with $BaCO_3$, with and without the addition of Na_2CO_3, and before the mixtures began to melt. When mixtures of quartz and $BaCO_3$ are heated in a stream of CO_2, evolution of CO_2 begins noticeably at about 700°. For mixtures in which $BaO:SiO_2 > 2:1$, the ratio $BaO:SiO_2$ in the reaction product is 2:1. In mixtures richer in SiO_2 the $BaCO_3$ reacts with a greater proportion of SiO_2, but not in stoichiometrical ratios. Thus, when the per cent of SiO_2 is greater than for $BaO:3SiO_2$ the amount of SiO_2 which reacts may be greater than that required by the ratio $1BaO:SiO_2$. Explanations are suggested for the difference in reactivity of mixtures high and low in silica. The addition of Na_2CO_3 to mixtures of BaO and SiO_2 lowers the temperature of noticeable CO_2 evolution to about 400°, and the composition of the reaction product depends on the composition of the mixture heated. For the isothermal heating of $BaCO_3$–SiO_2 mixture, at 750°, 850°, and 950°, the amount of CO_2 evolved is closely proportional to the logarithm of the duration of heating. This also holds for mixtures containing Na_2CO_3. (*C. A.*)

The structure of monticellite ($MgCaSiO_4$). G. B. BROWN AND J. WEST. *Z. Krist.*, **66**, 154–61 (1927).—Monticellite is orthorhombic, with 4 mols in the unit cell where $a = 4.815$, $b = 11.08$, and $c = 6.37$ A.U. The space group is V^{16}_h, and the structure is isomorphous with that of olivine. The O atoms approximate a close-packed hexagonal arrangement, with the remaining atoms in the interstices. (*C. A.*)

Rapid estimation of specific heat of solid material at low temperature. FRANZ SIMON AND MARTIN RUHEMANN. *Z. Physik. Chem.*, **129**, 321–38 (1927).—An apparatus

is described for measuring specific heats at low temperatures within small temperature intervals. A differential manometer is also described which measures pressure differences of 1 to 4 mm., over a 5-cm. range, accurate to 1%. Data are obtained on Ta, Cr, Co, Ni, Be, Sb, and Ce at temperatures between that of boiling and of evacuated N and O. The following critical temeratures were obtained: Ta, $\theta = 243.5$; Cr, $\theta = 486$; Co, $\theta = 383$; Ni, $\theta = 368$, and Be, $\theta = 1035$. (*C. A.*)

Physical properties of wet, dried and repeatedly dried soils. V. Kaš. *Věstník Českoslov. Akad. Zěmědelské*, **1**, 337 (1925); *Proc. Internat. Soc. Soil Sci.*, **3**, 93 (1928).—Air-drying of sandy clay soils reduces their hygroscopicity and water evaporating capacity; freezing has a similar effect. Drying or freezing of heavy soils increases their catalytic powers. This effect is also brought about by treatment with potassium silicate or with colloidal preparations of iron or manganese salts or humus. Fertility and catalytic activity in soils are closely related. Nitrification is reduced by the drying of soil. Acid formation in dried soil is more rapid, reaching a maximum earlier and subsequently decreasing more quickly than in moist soil. Drying increases the production of carbon dioxide in soils, the effect being cumulative with repeated wetting and drying. The difference in behavior resulting from drying a naturally moist soil can be used as a basis for measuring its fertility. Under natural conditions drying and freezing control soil activities mainly by regulating air and water supplies in the soil mass. (*B.C.A.*)

Silicic acids. IV. R. Schwartz and H. Richter. *Ber.*, **60** [2], 2263 (1927).—The authors, by vapor-pressure isothermals and X-ray diagrams, had previously established the existence of the compounds $SiO_2 \cdot H_2O$ and $2SiO_2 \cdot H_2O$. G. W. Morey and N. L. Bowen had proved that the alkali silicates formed corresponded only with these two acids; nevertheless, it was thought necessary to disprove the existence of $3SiO_2 \cdot H_2O$ and $3SiO_2 \cdot 2H_2O$. X-ray methods disproved the possibility of the latter, and in conjunction with vapor pressure, that of the former. The substance thought to be $3SiO_2 \cdot 2H_2O$ was a mixture of $SiO_2 \cdot H_2O$ and $2SiO_2 \cdot H_2O$, while that supposed to be $3SiO_2 \cdot H_2O$ was a mixture of $2SiO_2 \cdot H_2O$ and SiO_2. The acid obtained in gels could not be ascertained from the vapor-pressure curve, but on the grounds of moisture content was probably $2SiO_2 \cdot H_2O$. In alkali silicate solutions the ions SiO_3'' and Si_2O_5'' were found to exist in equilibrium, the former being stable only in strong alkali. (*J.S.G.T.*)

Thermal dissociation of strontium carbonate. E. O. Jones and M. L. Becker. *Jour. Chem. Soc.*, p. 2669 (1927).—In investigating the reaction between CO and CO_2 at high temperatures, use was made of dissociating $SrCO_3$ to fix the value of CO_2 pressure. In studying the dissociation, adsorbed gases on the vessel and carbonate were evolved, until constant heating and evacuation reduced the pressure to a steady value, that due to the carbonate alone. Decomposition pressures, obtained from both sides, were obtained from 0.6 mm. at 775° to 123 mm. at 1103°, and agreed with the formula

$$\log p_1 - \log p_2 = -K\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

where $K = 1.05 \times 10^4$. No evidence for a basic carbonate (as found by Finkelstein with $BaCO_3$) was met with, although decomposition between 15% and 85% completion was carefully noted. (*J.S.G.T.*)

A study of the structural changes in amorphous materials. Silica gel. W. A. Patrick, J. C. W. Frazer, and R. I. Rush. *Jour. Phys. Chem.*, **31**, 1511 (1927).—The adsorption of carbon tetrachloride by pure silica gel was measured over the temperature range 100–1150°, similar measurements being made using gel containing 0.28% sodium sulphate. Density determinations of the gel were made over the range 100–1100°. The results showed that the adsorption ability of the pure gel was not affected until it was heated above 900°, then a rapid decrease set in until 1000° was reached.

With the impure gel, the decrease began at a lower temperature, but again the lowest value was attained at 1000°. The density measurements showed that structural changes began at about 800°. It was proved that the pure gel changed to a crystalline form when heated at 1100°, and a theory was advanced to explain the structural change. (*J.S.G.T.*)

Factors affecting the coagulation of colloidal clay. R. BRADFIELD. *Jour. Phys. Chem.*, **32,** 202 (1928).—It is shown that the coagulation value of a colloidal clay may vary widely with slight changes in either: (1) hydrogen-ion concentration, (2) concentration of the clay sol, or (3) the nature and extent of the exchange reactions which take place when the coagulating agent is mixed with the clay. (*J.S.G.T.*)

Mechanical and electrical strength and molecular forces. A. JOFFÉ. *Phys. Z.*, **28,** 911 (1927).—The discrepancies between the observed values of the mechanical strength of crystals and the values calculated from the theory of M. Born and his coworkers are shown to be probably due to surface irregularities in the crystals used, since with surfaces under water, no great discrepancies occur for rock-salt crystals. Previous work indicated that for electric fields of a few hundred thousand volts per cm. the insulation of rock salt broke down. J. obtained fields greater than 10^7 volts per cm., and he attributes these high fields in crystals and glass to a very thin badly conducting layer, produced at one of the anodes by loss of ions. He considers that the rise of "sparking-potential" in these very thin layers, could be regarded as evidence of ionization by collision. The process and effect of ionization are treated mathematically, and it is shown that as soon as ionization by collision sets in, the break down of the dielectric is inevitable. Experiments were made on glass and mica, and the results applied to the theoretical equations. Thus it is shown that the potential for ionization by collision is a function of the field strength, a result not anticipated. It is also shown that the limit to which the electric field can be raised by diminishing the thickness of the badly conducting layer is of the order of 10^8 volts per cm. In a field of 1.5×10^8 volts per cm., the elastic energy of the ions is 10^{-12}, and the kinetic energy corresponds to a temperature of 1600° Abs., *i.e.*, the fusion region of glass. It is thus not surprising that the ions were "torn away" by the electric field under such circumstances. Between certain limits of thickness the "sparking potential" is found to be independent of the thickness of the badly conducting layer. The "sparking potential" is independent of the material of the electrodes and an internal effect of the dielectric. A new method for the production of insulators, condensers, etc., could possibly be founded on these results. (*J.S.G.T.*)

Influence of grain size on the dissociation pressure of solids. M. CENTNERZWER AND J. KRUSTINSONS. *Z. Phys. Chem.*, **130,** 187 (1927).—An attempt is made to confirm the deduction from Gibbs's thermodynamical potential, whereby vapor pressure depends, among other things, on the free surface,

$$ln\frac{p_2}{p_1}=\frac{2\sigma M}{RT\rho}\left(\frac{1}{r_2}-\frac{1}{r_1}\right)$$

where ρ is the density and σ is surface tension, p_1 and p_2 are vapor pressures of grains of radius r_1 and r_2, T the temperature, R the thermo-dynamical constant and M molecular weight. The pressures obtained agree with the formula within the limits of experimental error for $AgNO_3$ prepared in three different ways, namely, (1) from bicarbonate, (2) from ammoniate, (3) by precipitation. Attempts to investigate red and yellow HgO did not lead to complete agreement, owing mainly to the difficulty of measurement of size. Traces of water were found to exert considerable influence. (*J.S.G.T.*)

BOOKS

Photometric Chemical Analysis. Vol. I. Colorimetry. J. H. YOE. J. Wiley & Sons, New York, 1928. Price $11.00. H.H.S.

Dispersoid Analysis. F. V. von Hahn. T. Steinkopf, Dresden & Leipzig, 1928. Price 42 R.M. Part 5 of Ostwald's *Kolloidwissenschaft in Einzeldarstellungen.*

H.H.S.

Qualitative Analysis. William Wardlow and Frederic W. Pinkard. 166 pp. Longmans, Green and Co., London and New York, 1928. Price $1.25. Reviewed in *Amer. Jour. Sci.*, **16** [91], 76 (1928). F.P.H.

PATENTS

Production of alkali-metal compounds from silicates containing them. Thomas A. Edison. U. S. 1,678,246, July 24, 1928. The herein described method which consists in mixing finely divided silicate containing an alkali metal with an alkaline earth hydrate and water subjecting the mixture to sufficient heat to free the alkali metal from the silicate, and subjecting the resultant mass to a head of liquid sufficient to remove therefrom by displacement the water and soluble salts therein, substantially as described.

Production of commercial borax from $Na_2O \cdot 2B_2O_3 \cdot 4H_2O$. Thomas M. Cramer. U. S. 1,678,381, July 24, 1928. In the production of commercial borax from a natural-occurring sodium borate which resists solution, a method which includes: subjecting the mineral to a temperature sufficient to render the mineral less resistant to solution in water, dissolving the same in a watery medium; and crystallizing a commerical borax from the resultant solution.

Titanium compounds. I. G. Farbenindustrie Akt.-Ges. Brit. 290,174, July 4, 1928. Titanium ores are treated with sulphuric acid and the titanium then brought into solution as a double salt by treatment with an alkali salt such as sodium, potassium, or ammonium sulphate. Preferably the solution step is effected under heat and the proportions so chosen that a saturated solution is obtained from which after filtration, the double salt may be crystallized out. The crystals may be washed with a saturated solution of alkali sulphate or be recrystallized from dilute sulphuric acid to free them from iron. From a solution in dilute sulphuric acid or a suspension in water of the double salt titanic acid may be obtained by hydrolysis, if desired under pressure. The mother liquor containing sulphuric acid and alkali sulphate may be used in the solution step of the process.

Titanium phosphate. P. Spence & Sons, Ltd., and S. F. W. Crundall. Brit. 290,683, July 11, 1928. The precipitation of hydrated basic titanic phosphate by mixing phosphoric acid or a phosphate with a solution of a titanic salt is carried out with a solution of the titanic salt having a free acid content in excess of the equivalent of 15% SO_3; when using sulphuric acid, the acidity may be increased up to 50% free SO_3, and when using hydrochloric acid, up to the saturation point of the latter. By this means, the concentration of titanic oxide in the solutions used may be increased to over 10% and the precipitation may be effected at temperatures below 50°C, a temperature as low as 15°C being mentioned. Mother liquor from the precipitation step may be used in a subsequent operation, or in other ways; for instance, when containing free hydrochloric acid, the mother liquor may be used to prepare barium chloride from witherite; and when sulphuric acid is present, it may be used in the extraction of ilmenite. An example describes the preparation of a composite product by conducting the precipitation in a solution containing a paste of barium sulphate. The finely divided precipitates obtained may be used in the preparation of pigments.

Titanium oxide. P. Spence & Sons, Ltd., and S. F. W. Crundall. Brit. 290,684, July 11, 1928. Titanium oxide, or a mixture containing it, for use particularly as a pigment, is prepared from an insoluble titanium phosphate, such as basic titanium phosphate, by reacting the latter with a base in the form of an oxide, hydroxide, or salt of a volatile or weak acid such as a carbonate. The phosphate may be treated in suspension with a solution or suspension of the base, preferably by boiling, and the product

calcined; or the phosphate and base may be mixed intimately in a dry state and the mixture calcined. When a soluble or readily fusible phosphate, such as sodium phosphate, is obtained by the reaction, it may be washed out with water; when on the other hand, an insoluble phosphate, such as calcium phosphate, is obtained, this may either remain in the product or be removed as by dilute acid. By treating a mixture of the titanium phosphate and barium sulphate a white pigment may be obtained; and by using, as reagent, ferric oxide or chromium oxide, colored pigments result. In examples, a mixture of basic titanium phosphate and ferrous sulphate is calcined at 700–800°C to give a red pigment, and a mixture of basic titanium phosphate, barium sulphate, and ammonium bichromate is calcined at 700–800°C to give a green pigment.

General

Equations and tables for shrinkage, expansion, and design calculations. A. E. R. WESTMAN. *Jour. Amer. Ceram. Soc.*, **11** [9], 715–23 (1928).—Attention is drawn to an error in the equation for calculating linear shrinkage (per cent of dry length) from volume shrinkage (per cent of dry volume) which was given in the Report of the Committee on Standards, AMERICAN CERAMIC SOCIETY, *Year Book, 1921–22*. In order to avoid errors due to the use of incorrect equations, in future work, the more useful equations for making the ordinary shrinkage, expansion, and design calculations are derived and tabulated. To facilitate numerical computation, four-figure tables are given by means of which the labor involved in the more usual ceramic calculations involving shrinkage and expansion can be greatly reduced. The use of the equations and tables is explained and illustrated by means of examples.

The coöperative effort. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [8], 225–26 (1928).—It is pointed out that there is no monopoly of ceramic knowledge. Only by coöperation and pooling of discoveries and developments can rapid progress be made by all. The AMERICAN CERAMIC SOCIETY is an organized agency through which the coöperation may be brought about. E.J.V.

Our competitors. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [8], 226–27 (1928).—The success of substitute products despite proved superiority of clay and glass is deplored. Causes are pointed out and the cultivation of a market by studying the artistic and engineering value of ceramic products for specific purposes is urged. E.J.V.

Glass technologists tour Germany. III. ANON. *Pottery Gaz.*, **53** [614], 1265–77 (1928); *Glass Ind.*, **9** [8], 184 (1928).—A report of the conclusion of the tour of Germany with a joint conference of the Society of Glass Technology and the Deutsche Glastechnische Gesellschaft at Aachen. Papers presented at this conference included: "Definition and Measurement of the Physical Properties of Glasses," by M. Thomas; "The Relationship between Physical Properties of Glasses and Suitability for Manipulation by Machine," by F. W. Adams; "Modern Development of Refractory Materials," by W. J. Rees; "German Views on Refractories," by W. Miehr; "Properties of Boric Oxide-Silica Glasses," by W. E. S. Turner; "Velocity of Crystallization of Soda-Lime-Silica Glasses," by E. Zschimmer; "Glass-melting Furnace as a 'Heat Engine'," by D. Aufhauser; "Expansion and Tensile Tests on Glasshouse Refractories," by J. F. Hyslop, R. F. Proctor, and H. C. Biggs (read by B. P. Dudding); "Physical Properties of Clay," by G. Gehlhoff; "Amount of Gases and Water Contained in Glasses," by H. Salmang; "Influence of Cullet in Glassmaking Operations," by W. E. S. Turner; and "The Annealing of Glass," by E. A. Coad-Pryor. For Parts I and II see *Ceram. Abs.*, **7** [7], 533; [9], 647 (1928). E.J.V.

Zinc cartel. ANON. *Ceram. Ind.*, **11** [2], 154 (1928).—The recent international zinc conference at Brussels did not result in an actual organization of a world or even European zinc cartel; it has gone a long way toward bringing about a coöperation of

European interests and is making serious efforts to attract American interests to a world combination. The American Consul at Frankfort-on-Main made this report public through the Department of Commerce. F.P.H.

Combustion process and heat transition in the steam boiler. FRITHJOF ROHR. *Feuerungstechnik*, **16** [2], 13–17 (1928).—The subjects considered are: (1) combustion of solid fuels, (2) development of a new theory of combustion and heat transition, (3) comparison of the results with the well-known theory of combustion F.P.H.

Size of boilers. SCHLICKE. *Feuerungstechnik*, **16** [3], 29–33 (1928).—Factors influencing the selection of the size of boilers for various installations and economy are discussed. F.P.H.

Economy of electricity in ceramic plants. KARL SCHMARJE. *Keramos*, **7** [8], T7 (1928).—Electrical power in ceramic plants is compared with other forms of power. F.P.H.

Ceramic terms defined. ANON. *Keramos*, **7** [9], T10; [10], T10; [11], T10; [12], T10 (1928).—A short encyclopedia of ceramic terms is given. The first section deals with raw materials and gives the composition, occurrence, and uses of various materials used in ceramics. F.P.H.

Trade ethics pay. F. M. BESSANT. *Crockery and Glass Jour.*, **106** [12], 25 (1928).—B., discusses the advisability of a buyer trading with a manufacturer who copies and cheapens the designs of a competitor. B. claims that such conduct does not pay the buyer. E.P.R.

Mechanical stoker at Barking Electricity Station. UNDERFEED STOKER CO., LTD. *Mech. World*, **83** [2143], 63 (1928).—A recent application of the "underfeed" type "L" traveling grate stoker is found in the combustion chamber of one of the Yarrow boilers at the Barking superpower station, London. The stoker has twin chains and a net effective width of 19 ft. The amount of coal burned on normal duty is 10,000 lbs. per hour, with an overload of 16,000 lbs. The boilers have a normal evaporation of 68,000 lbs. of water per hour. E.P.R.

Further economy in steam generation. ANON. *Mech. World*, **83** [2145], 93–94 (1928).—The efficiencies of different types of coal when burned and wood-refuse burning are discussed. E.P.R.

Boiler feed-water problems. SHEPPARD T. POWELL. *Mech. World*, **83** [2161], 403–404 (1928). E.P.R.

Barrow work in the brick industry (the human factor). G. P. CROWDEN. *Brit. Clayworker*, **37** [434], 105–108 (1928).—A synopsis of the report of an investigation undertaken by the Industrial Fatigue Research Board entitled, "The Physiological Cost of the Muscular Movements Involved in Barrow Work." The report covers the following subjects: (1) physiological cost of work, (2) investigation of barrow work, (3) factors involving energy expenditure, (4) work done in raising handles, (5) optimum load, (6) optimum arrangement, (7) optimum rate of wheeling. R.A.H.

Experiments in underground communication through earth strata. L. C. ILSLEY, H. B. FREEMAN, AND D. H. ZELLERS. Bur. Mines, *Tech. Paper*, No. 433, 60 pp. (1928).—The chief purpose of Bureau of Mines experiments in underground communication has been to devise some practical means of communicating with entombed miners. In this *Bulletin* the various studies on underground communication are correlated. The subject matter is presented under 4 major divisions as follows: (1) signaling with geophones; (2) radio apparatus; (3) ground conduction (T.P.S.) apparatus; (4) telephone. Under summary of findings of investigation are given: (1) two methods of underground communication seem to promise usefulness: (*a*) the geophone or earth-vibration method, and (*b*) the grounded-line or roof-rail conduction method of communication with telephones; (2) in the earth-vibration method the transmitter is a sledge or rock and the

receiver is a geophone, the greatest drawback being that voice communication is impossible, and the use of code to any extent is difficult; (3) the transmitter in the roof-rail system of communication is an ordinary microphone used straight or with amplification. The roof-rail system method employs either voice or code. The advantages of a combination of the two systems are discussed. R.A.H.

Institution of Chemical Engineers. ANON. *Chem. and Ind.*, **47,** 800–804 (1928).—The examination papers for the associate-membership of the Institution. H.H.S.

Award offered by Chilean Nitrate Educational Bureau. P. E. BROWN. *Chem. and Ind.*, **47,** 807 (1928).—An annual award of $5000 to research workers in North America for knowledge on the role of *N* in agronomy. B., the secretary-treasurer of the Amer. Soc. of Agronomy, which sponsors the award, is at Iowa State College, Ames, Ia. H.H.S.

Ceramists' tour abroad. ANON. *Ceram. Ind.*, **11** [2], 170–76 (1928); *Chem. and Ind.*, **47,** 777 (1928); *Glass Ind.*, **9** [8], 184 (1928); *Nat. Glass Budget*, **44** [14], 8 (1928); *Pottery Gaz.*, **53** [614], 1251–64 (1928).

Convention of Canadian National Clay Products Association. ANON. *Clay-Worker*, **90** [1], 32 (1928); *Clay Prod. News*, **1** [4], 1–4 (1928); for abstract see *Ceram. Abs.*, **7** [9], 646 (1928).

Book Reviews

Ceramic Products Cyclopedia 1928. Industrial Publications, Inc., Chicago. Price $12.00.—One of the most impressive contributions to ceramic literature is the 1928 issue of the Ceramic Products Cyclopedia. The book is an outstanding work of its kind, and its 564 pages are packed with valuable data. Practically every phase of ceramic ware manufacture is thoroughly discussed, and the description of plant equipment is excellent. There are 383 pages of informative reading on ceramic practices, formulas, and helpful data on all problems in enamel, glass, pottery, terra cotta and heavy clay products. There are 865 drawings, photographs, and diagrams to illustrate the 1216 informative items which are arrangeed in sections. The batch section contains batches of practically every ceramic product and complete information on the calculations of all ceramic batches. The two sections which are especially noteworthy are those on kilns and furnaces, and raw materials. This book should be on the desk of every ceramic plant. G.B., Jr.

Clays of Louisiana. J. W. WHITTEMORE. Louisiana Dept. of Conservation, *Bulls.*, No. 14, 84 pp., and 16, 189 pp. (1928).—The former covers the Shreveport area and the latter the Monroe-Ruston area. W. has shown the rare judgement of confining his attention to securing representative samples, giving each a series of practical tests and simply reporting the data obtained. He has clearly set forth industrial value of the clays tested. Published by the State of Louisiana, Dept. of Conservation, New Orleans Court Bldg.; V. K. Irion, commissioner.

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering COLUMBUS, OHIO

Founded 1895

Curriculum—Ceramic engineering and technology. Advanced research in cooperation with State owned plants and Federal Government.

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

Research Professor: GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering URBANA, ILLINOIS

Founded 1905

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products.

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate.

THREE INSTRUCTORS *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics.

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT

Curriculum—Ceramic Technology and Engineering

TWO INSTRUCTORS *Founded 1923* *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—students selection of ceramics includes chemical and engineering principles applied to ceramic manufacture.

TWO INSTRUCTORS AND TWO ASSISTANTS *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827. Department of Metallurgy, Ceramic Division, 1925.

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON *Founded 1926* *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering *Head of Department:* J. W. WHITTEMORE

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries.

Founded 1926 *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts COLUMBUS, OHIO

Founded 1927

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A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 7 | October, 1928 | No. 10

EDITORIALS

WHY ANNUAL MEETINGS

A prominent ceramist who is serving as an officer of one of the Divisions of the AMERICAN CERAMIC SOCIETY expressed concern about a proposed annual meeting program not furnishing the number of papers required for the *Journal*. The response to this statement was that the securing of "copy" for the *Journal* was not the chief object of the annual meetings.

This *Journal* is not an objective in the plans for the annual meetings. It is not even the final purpose of the SOCIETY. The *Journal* is a means to the end for which twenty-six hundred persons are coöperating through the agency of the SOCIETY. The *Journal* is their record of information exchanged, plans made, and the literature on ceramics abstracted and indexed. This work is done by the members to better their knowledge individually and collectively.

The annual meetings would repay the individual members who participate and would further the progress of ceramic art, science, and technology generally, even if none of the papers later appeared in the *Journal* of the SOCIETY.

The SOCIETY issues the monthly *Journal* wholly and simply as a means of making a record; of prompting the members to make available in exchange with their fellow members the results of investigations and

observations, and to keep in step, mutually on all measures that will advance the art, science, and technology of ceramic ware production. The *Journal* is in no wise a commercial enterprise.

The annual meetings are for personal inspiration, for broadening and strengthening acquaintances, and for collectively planning the most effective means of promoting ceramics. A member's facilities to acquire and accomplish ceramic information are increased with increasing acquaintances and friendships among fellow ceramists. The annual meetings afford an opportunity for the men from the clay, glass, and vitreous enamel industries to exchange experiences, theories, and ambitions, which if denied them would result in narrowing of concepts and limitations in vision.

Both the *Journal* and the meetings have their distinct value and they are nearly parallel in purpose. They are, however, in no wise interdependent. The annual meetings are not planned to acquire "copy" for the *Journal*.

WHY AN EXPOSITION OF CERAMIC PRODUCTS

Each January, the potters and glass manufacturers have a show in Pittsburgh. This show serves the excellent purpose of educating the store buyers, who sadly need this service, on what the public wants and needs. There should be no curtailment of this annual show.

Perpetual exhibits of floor, wall, and building tile, and of brick panels are found in sales offices and in some architect's offices. There are also permanent exhibits in the sales "marts" of New York and Chicago which repay those who use them.

National and direct mail advertising of ceramic products are effective means for letting ceramic products be known.

There are also expositions of products for the education of ultimate purchasers as another means of telling the service value of ceramic products. Such expositions do not duplicate these other means of making known the service advantages of ceramic products. They serve the same ultimate purpose of increasing sales but their appeal is differently directed.

The Exposition during Ceramic Week, Chicago, February 4 to 9, inclusive, at the Stevens Hotel is an opportunity of which each ceramic firm should avail itself.

ACTIVITIES OF THE SOCIETY

AMERICAN CERAMIC TOUR ABROAD

Letters from the tour members and from the individual hosts are slowly coming in, and all of them enthusiastically praise the tour of the American ceramists held last May. These will be published together with photographs taken by members of the tour. For the present, a few photographs are offered to continue the story of the American ceramists in Europe.

FIG. 1.—Outside A. Lacroix & Co., Paris. Gathering for the first plant visit, May 29. (Taken by R. E. Elliott.)

FIG. 2.—In the yard of the oldest pottery in Limoges. (Taken May 31 by R. E. Elliott.)

FIG. 3.—Dinner in a "Charmille" at Aix-sur-Viennes (Limoges party). This shows only one-half of the Limoges party. (Taken by R. E. Elliott, May 31.)

FIG. 4.—Drawing flint in Limoges. (By R. E. Elliott.)

FIG. 5.—Office of Tuileries de Beauvais Tile. (By Clarence E. Fulton, May 30.)

FIG. 6.—A group on Lake Lucerne taken June 5 by W. Jackson, Jr.; from left to right: *top row:* R. C. Purdy, B. Hood, G. H. Brown; *seated:* C. Hood, Mrs. Warren, Mr. and Mrs. D. V. Cable.

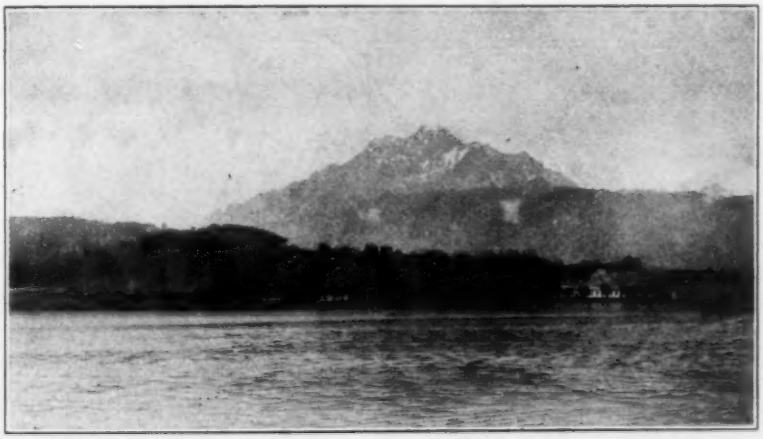

FIG. 7.—Snow-capped Alps from Lake Lucerne. (Taken by Stuart Phelps, June 5.)

FIG. 8.—Stuart Phelps inspecting the locomotives which hauled us up Mt. Rigi in Switzerland. (By Clarence E. Fulton.)

FIG. 9.—The Ceramic School at Karlsbad. (Taken June 9 by R. E. Elliott.)

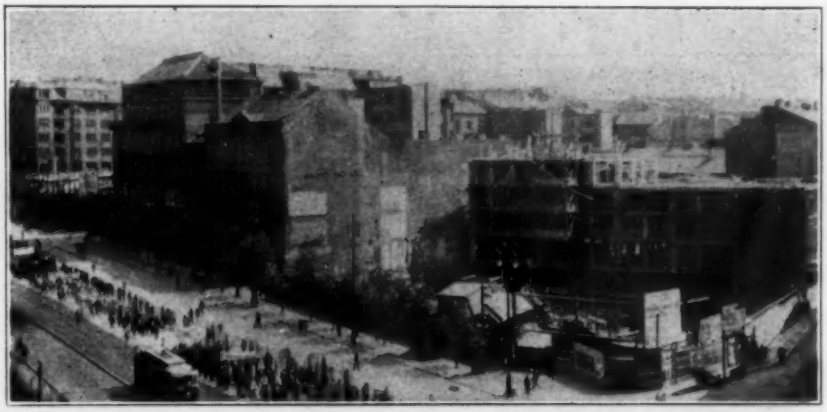

FIG. 10.—From my window in Prague: Sunday's procession. Note the extensive rebuilding. (Taken by R. E. Elliott.)

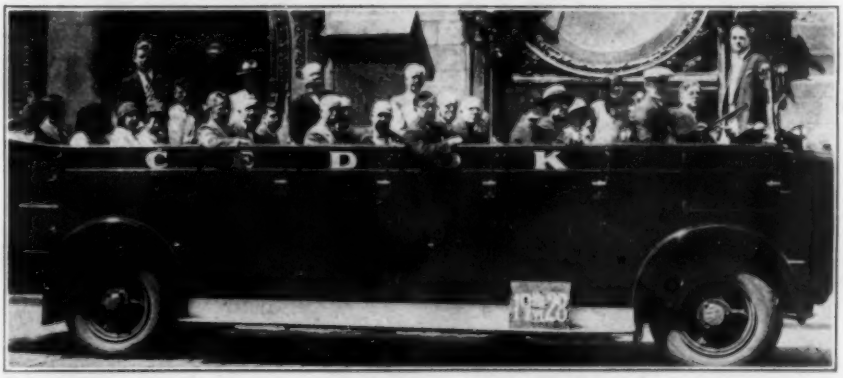

FIG. 11.—Prague, in front of Town Hall. One-third of party. (Taken by Clarence E. Fulton, June 10.)

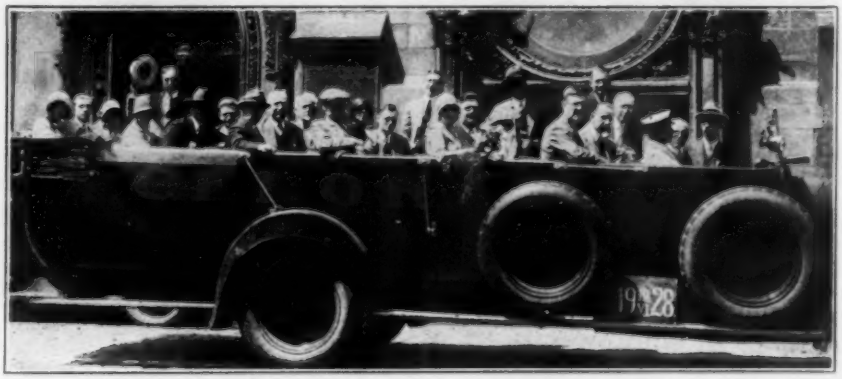

FIG. 12.—Prague, in front of Town Hall. Another group of the party. A third of the party was in Brno studying the Czech State Institute for Silicate Industries.

FIG. 13.—Dr. Rodl; Mrs. Harkort and her three boys, Hans, Dietrich, and Gunter. (Taken by R. E. Elliott at Potsdam, June 17.)

FIG. 14.—Dr. and Mrs. Harkort and family, Dr. Rodl, E. L. Hettinger and R. E. Elliott. (Potsdam, June 17.)

FIG. 15.—Landing at Meissen by boat. (Taken by R. E. Elliott, June 13.)

FIG. 16.—John and Alice, our youngsters.

FIG. 17.—A smile that may "Czech" but never crack. "Czech" is Mrs. F. E. Hodek, Jr.

NEW MEMBERS RECEIVED FROM AUGUST 1 TO SEPTEMBER 1

Malcolm Barker, P. O. Box 948, Durban, Natal, Falkirk, Scotland, Manager-director Durban-Falkirk Iron Works.

Ray D. Bryan, Babcock & Wilcox Co., Packard Bldg., Philadelphia, Pa., Salesman in Charge, Refractories Dept., Philadelphia District.

Chas. R. Essick, 439 Oley St., Reading, Pa., Manager, Pennsylvania Optical Company.

John K. Hill, Victor, N. Y., Sales Engineer, Taylor Instrument Company, Rochester, N. Y.

Hans Hirsch, Chemisches Laboratorium fur Tonindustrie, Dreyestrasse 4, Berlin, N. W. 21, Germany.

George C. Irvine, 165–66th St., Niagara Falls, N. Y., Ceramic Assistant Carborundum Company.

William F. Mooney, Steubenville Pottery Co., Plant 2, Assistant Superintendent, Steubenville, Ohio.

Robert M. Simmons, 2047 Las Colinas Ave., Los Angeles, Calif., Superintendent, International Clay Products Co., Inc., Alhambra, Calif.

Peter Finlayson Waddell, 20 Alma St., Falkirk, Scotland, Manager Enameling Department and Chief Chemist for Foundry.

Membership Workers' Record

	PERSONAL		PERSONAL
J. E. Brinckerhoff	1	Office	2
A. M. Cleverley	1		—
George Guthrie	1	Total	9
V. K. Haldeman	1		
E. L. Hettinger	1		
W. L. Shearer	1		
P. H. Walker	1		

NEWS FROM THE LOCAL SECTIONS

Pacific Northwest Section

Delegates from Washington, Oregon, and Idaho held an interesting summer meeting of the Pacific Northwest Section with the Pacific Northwest Brick and Tile Association, August 31, at the Chamber of Commerce Building, Yakima, Wash.

The morning was spent in visiting the local cold storage and canning plants for apples, pears, and other fruit which have made the Yakima Valley famous. The program for the afternoon session lead by Vice-president Alex H. Corbett included the following papers:

"Drain Tile and the Farmer," A. B. Crane, drainage specialist for the Washington State College Extension Department.

"Lime Mortars," by Stuart Mannell, sales manager for the Pacific Lime Company.

"Ceramic High School Exhibit in Preparation for the College of Mines, University of Washington," by Dean Milnor Roberts.

The banquet in the evening was followed by a program of papers as follows:

"Imported Irish Colors for Face Brick," F. T. Houlahan, Builders Brick Company, Seattle.

"A Ceramic Auto Tour through the East," Hewitt Wilson, University of Washington.

Sam Kiefer, Secretary of the Yakima Farm Bureau as Peter Spraynozzle, gave an humorous account of a recent visit to Seattle.

W. F. Clarke, of Yakima gave an illustrated lecture on the New Naches Pass Highway through the Cascade Mountains and showed views of Mt. Ranier.

A. B. Fosseen, Washington Brick, Lime, and Sewer Pipe Company, Spokane, led the golf match held on Saturday morning and the Seattle Brick and Tile Company took the prize for company attendance. Credit for the preparation of the program and arrangement details belongs to Alex H. Corbett, President of the Granger Clay Products Company and to W. J. Howard, Secretary of the Pacific Northwest Brick and Tile Association.

Pittsburgh Section

Members of the Pittsburgh Section will meet Tuesday evening, October 9 in the Fellows Room, Mellon Institute. Alexander Silverman, head of the Department of Chemistry, University of Pittsburgh, will speak on "The Art and Manufacture of Glass in Europe."

NOTES AND NEWS

COLORS IN CERAMICS

EDWIN W. ELY

(Division of Simplified Practice)

Nowadays there is an increasing number of manufactured products in which color has become a pronounced factor. Automobiles, stoves, kitchen utensils, tools, hat bands, stockings, all have a claim on the spectrum. Whether this means that we as a nation are declaring our collective and personal optimism of the "rightness of things as they are," or whether some other motive urges us to develop a sense of contrast, the fact remains that we are rivaling nature herself in the language of color.

The question has been asked recently, "Is the wide variety of shades, hues, tints and colors a repudiation of the principles of Simplified Practice, and cannot simplification be invoked to curb or at least arrest the tendency to apply color to everything?"

In answering this question it will be appropriate to first define Simplified Practice. Simplified Practice means the reduction of variety in sizes, dimensions and *immaterial* differences, of everyday commodities as a means of eliminating waste, decreasing costs and increasing profits and values in production, distribution and consumption.

The reader's attention is called to the word "*immaterial*" in the definition, and the fact that it is italic by way of emphasis, for in that word rests the heart of the simplification movement.

Difference in color, as applied to a given commodity, is an "immaterial" or a "material" consideration according to the viewpoint from which the problem at hand is regarded. If color is considered in conjunction with articles of ornamentation or commodities, that provide a vehicle for the expression of personality and personal taste, then the question resolves itself into one of aesthetics. These differences may not be vital, economically. They are important, nevertheless, and may be regarded as "material" differences.

Repairs and replacements which require the harmonizing or blending of colors, create a situation which is not essentially different from that presented in the problem of interchangeability in machines. Colors must match, harmonize with or be complements of each other; parts of a machine must "fit." Again we are faced by "material" differences.

If color is regarded in connection with articles of utility, then the aesthetic side is less important while the economic side is more heavily stressed. Will a tool or any other useful commodity perform its destined function just as well while wearing one color as another? Will it perform that function less expensively if manufactured in a simplified range of colors, or with no color at all, than is the case when it is coated with color?

Assuming that color is a side issue and the question of price primary, it may be said that a clear case of "immaterial" differences is exemplified. In such circumstances simplification should offer tangible benefits to all concerned without in any way interfering with personal taste, or the expression of individuality in design and creation.

An analysis of this kind might or might not be considered practicable by an industry, in view of other controlling factors. At any rate it will be interesting to here set down the facts that attend the production of commodities in a wide variety of colors:

The manufacturer must tie up his capital in extra equipment in order to maintain production of the full line of colors. His inventory is rendered more complex and expensive, and he must have additional storage facilities. He is manufacturing for an uncertain demand and he is confronted with a variable factor of style which he never suspected would intrude itself into his business. His commodity may be a humble article of utility, but he now shares with the manufacturers of clothing, the speculative risks that go hand and hand with styles. These are all overhead costs and they eventually find their way to the consumer.

The distributor is faced with problems of inventory, heavy investment to meet all demand, extra space and additional rent. He adds his costs to those which have been passed on to him by the manufacturer, and again the consumer comes into the picture.

The consumer in many instances is confused by the wide range of choice that is presented to him. He desires only utility, but he pays for an ornament.

If the producers, distributors and users are of one mind in regard to the economic advantage of conforming to a simplified list of colors, it would be possible to establish

such a list by the unanimous consent of all concerned. With all elements in an industry coöperating, it should be possible to arrive at conclusions that would prove mutually satisfactory.

The situation may be summed up as follows: (1) Over-diversification is wasteful. (2) Over-standardization stultifies and restricts. (3) Simplification, intelligently and moderately applied, offers a middle ground or happy medium between these two extremes.

USE OF HYDROCHLORIC ACID FOR TESTING ACID-RESISTING ENAMEL

L. E. Barringer, of the General Electric Company recently questioned the use of hydrochloric acid for testing the acid-resisting enamel. The point has been taken up by A. Malinovszky of the Washington Iron Works with the following points.

A. MALINOVSZKY: The paper[1] was on the topic of cast-iron sanitary ware only. For this reason it is necessary that the enamel must resist hydrochloric acid. If the enamel resists hydrochloric acid, it will resist fruit of all kinds, vegetable and organic acids. After a tub or sink is set, and the tile setters are finished, hydrochloric acid is used to clean the tiles. Should this acid drop on the tub or sink, as it has happened in many instances, the result would be disastrous.

Some tubs are worth $60, and if tiled in are worth $200. If such tubs are ruined by acid they will always show the dirt where the enamel had been attacked by the acid.

Taking a combination sink or a double drainboard sink, the price of which is about $100, when a half lemon or tomato is placed on the enamel, the latter is destroyed if it lacks the acid-resisting qualities. Thus, many lavatories are spoiled by placing lemon, or soap containing lemon, on the lavatory, after having been used as a hand lotion.

The water in California seriously attacks the enamel in many localities, especially where artesian water is used. There are places in Los Angeles, Long Beach, Elsinor, Murietta Spring, Norco, etc., where the enamel is discolored black by this water. Architects today specify acid-resisting enameled sanitary wares for hospitals and other public places.

Nevertheless, too much is expected of acid-resisting enamels. Some of the specifications call for the enamel to resist hydrochloric acid, fruit and vegetable acids; other specifications call for the enamel to resist, mercurochrome, silver nitrate, bromides, iodine and other chemicals used in therapeutic baths. I do not think that an enamel can be produced to resist acid and alkalis of all kinds.

The Standard Sanitary Company was the first to put acid-resisting enameled plumbing fixtures on the market. The second company was the Washington Iron Works which placed acid-resisting plumbing fixtures on the market white and in colors.

Acid-resisting enamel can be made for stoves and refrigerators. In fact it should not be difficult to use acid-resisting enamels for refrigerators as the temperature is not as severe on the enamel and metal as the almost boiling water passed into a cold bath tub, or other plumbing fixture, where extreme changes of temperature take place continually.

The alkaline content of a soap has no effect on acid-resisting enamel.

CERAMIC SHORT COURSE AT THE OHIO STATE UNIVERSITY

December 3-8, 1928

A week of intensive consideration of methods for the control of ceramic processes and products. This course is especially designed to interest both the practical and the

[1] See A. Malinovszky, "Acid-resistant Enamels," *Jour. Amer. Ceram. Soc.*, **11** [2], 110–13 (1928).

technical ceramic worker and will include divisions on refractories, heavy clay ware, stoneware, whiteware, and enamels. Time will also be provided for consideration of special problems which may be suggested by those in attendance.

A request is made that applicants register at once and suggest topics for special attention. Address: Prof. Arthur S. Watts, Ceramic Department, O. S. U., Columbus, Ohio.

THE INDIAN CERAMIC SOCIETY

On April 15, 1928, the Indian Ceramic Society was organized "to promote friendship and coöperation between all those who are engaged in the manufacture of ceramic goods or in teaching ceramics, or those in any way connected with ceramics and interested in the advance of the knowledge, art, and technology connected therewith." The Society aims at "improving the condition of the ceramic industries of India and also to add to the general fund of knowledge of ceramics of the world." The outline of work for the organization proposes the following activities: (1) To hold annual general meetings and also sectional meetings. (2) Through a subcommittee to establish coöperation between industry and educational institutions and laboratories throughout the country; this committee is also authorized to take any steps necessary to establish new centers of education and to enlarge the present ones, as well as the establishment of technical ceramic laboratories. (3) To publish a Journal of the Society; the Journal will contain reports of the activities of the Society, reports about clays, feldspars, and other raw materials of India; it will also include a directory of the dealers in raw materials, etc. (4) To build up a Museum of the raw materials and finished products. Foreign goods of the best quality will be placed there for comparison. (5) To build up a central library which will be useful to all members. (6) To create technical literature in vernaculars. (7) To organize and educate the Kumbhars, etc., who are working in the clay industries for generations but are not well acquainted with modern technology. (8) To organize the industry and make an united demand for tariff protection or any other help obtainable from the Government.

The history of the organization of this Society is interesting. In 1921 Sirdar Krishan Singh circulated a letter to some friends then engaged in clay industries inviting their suggestions for the organization of an Indian Ceramic Society. The idea did not receive a sufficient response at that time to have any definite results. While T. W. Talwalkar, Honorary Secretary of the Society, was attending school in America he was greatly impressed with the American spirit of organization and after considering the tremendous work which has been done with coöperative spirit by the AMERICAN CERAMIC SOCIETY, he thought that a similar attempt should be made in India. He immediately found active support and a provisional organization was completed. With the generous help of the Benares Hindu University, the inaugural meeting of this Society was held at Benares on April 15 to 17, 1928, and the All India Glass Manufacturers' Association also met concurrently.

Twenty-six people attended the first meeting of the Society and forty-eight have enrolled as members. The officers elected are S. Deb, Behar Potteries, Ltd., Patna, *President;* I. D. Varshneya, Bahjoi, Sirdar Krishan Singh, Katni, M. B. Rane (Prof.) Benares, *Vice-presidents;* T. W. Talwalkar, Poona, *Secretary;* R. D. Chandorkar, Talegaon, *Treasurer.*

MONOGRAPHS ON GLASS PRODUCTION

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CALENDAR OF CONVENTIONS

American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1929	New York City
AMERICAN CERAMIC SOCIETY (Annual Meeting)	Feb. 4–9, 1929	Chicago, Ill.
American Concrete Institute (Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Gas Assn. (Annual Meeting)	Oct. 8–12	Atlantic City, N. J.
American Soc. of Mechanical Engrs.		
(Regional)	Oct. 1–3	Boston, Mass.
(Annual Meeting)	Dec. 3–7	New York City
American Soc. for Steel Treating		
(Annual Meeting)	Oct. 8–12	Philadelphia, Pa.
(Semi-Annual)	Jan. 14–18, 1929	Los Angeles, Calif.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Assn. of Scientific Apparatus Makers of America	May 3, 1929	Atlantic City, N. J.
Common Brick Mfgrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
German Glass Technology	Nov. 15–16	Berlin, Germany
Natl. Academy of Sci.	Nov. 19–21	Schenectady, N. Y.
Natl. Assn. of Manufacturers	Oct. 22–25	New York City
Natl. Assn. of Mfrs. of Heating and Cooking Appliances	May 8–9, 1929	New York City
Natl. Brick Mfrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Exposition of Power & Mechanical Engrs.	Dec. 3–8	New York City
Natl. Glass Distributors Assn.	Dec. 4–5	Pittsburgh, Pa.
Optical Society of America	Nov. 1–3	Washington, D. C.
Safety Congress	Oct. 1–5	New York City
Taylor Society	Dec. 5–8	New York City

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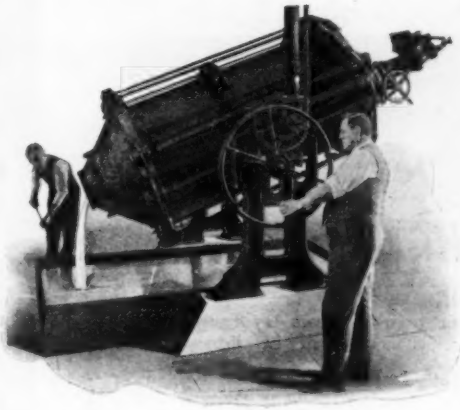

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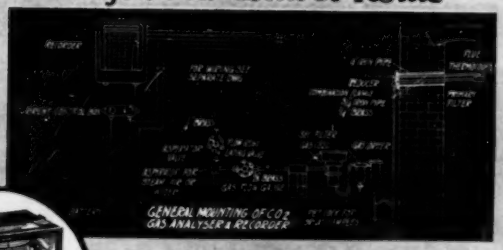

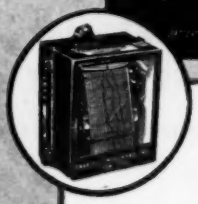

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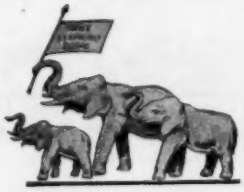

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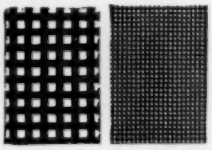

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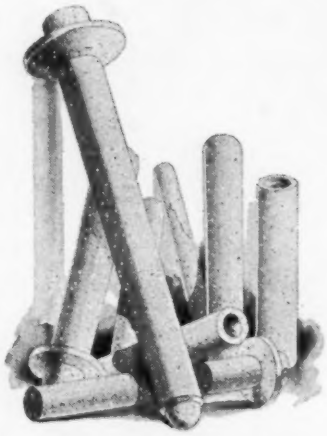

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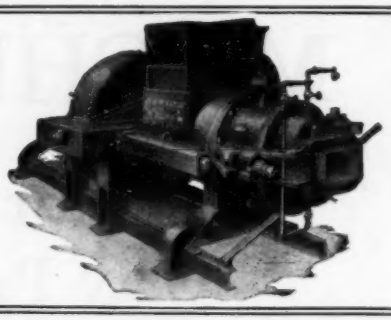

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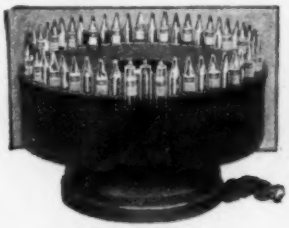

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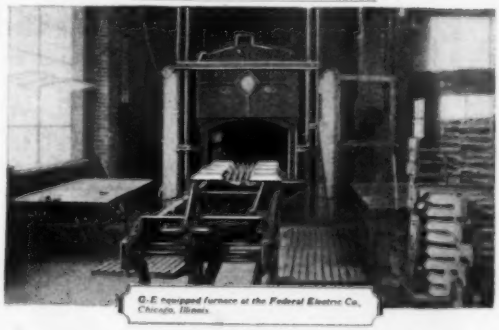
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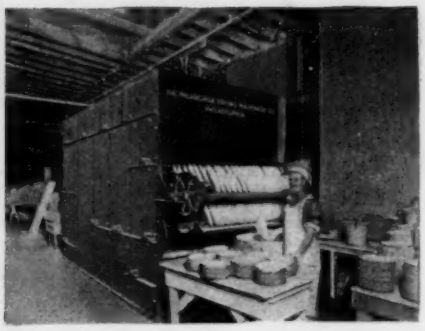

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